Pacific Island Network
Vital Signs Monitoring Plan

Appendix E: Topical Working Group Report – Invasive Species

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Pacific Island Network (PACN)

Territory of Guam
War in the Pacific National Historical Park (WAPA)

Commonwealth of the Northern Mariana Islands
American Memorial Park, Saipan (AMME)

Territory of American Samoa
National Park of American Samoa (NPSA)

State of Hawaii
USS Arizona Memorial, Oahu (USAR)
Kalaupapa National Historical Park, Molokai (KALA)
Haleakala National Park, Maui (HALE)
Ala Kahakai National Historic Trail, Hawaii (ALKA)
Puukohola Heiau National Historic Site, Hawaii (PUHE)
Kaloko-Honokohau National Historical Park, Hawaii (KAHO)
Puuhonua o Honaunau National Historical Park, Hawaii (PUHO)
Hawaii Volcanoes National Park, Hawaii (HAVO)

http://science.nature.nps.gov/im/units/pacn/monitoring/plan/

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EXECUTIVE SUMMARY

The NPS Pacific Island Monitoring Network (PACN) is faced with the task of monitoring ecological change and impairment in a geographic region undergoing rapid alteration by invasive species that almost always become established initially far from the parks, often (especially for invertebrates) near ports-of-entry, but also often (especially for invasive plants) in urban, suburban, and rural areas. A proactive role for PACN, working with partners and the public, in surveillance for detection of potential new invasions that can negatively affect park ecosystems, is warranted.

The purpose of an NPS program for invasive species early detection is to allow opportunity for rapid response involving containment and possibly eradication or biocontrol by other agencies or through local partnerships. Involvement in this activity will stimulate collective action and will allow NPS to be knowledgeable and involved in proactive management of invasive species, beginning with the prevention stage, rather than simply reacting when an invader reaches park boundaries.

Early detection and effective rapid response are feasible in some instances, but not in others. Vascular plants and ants are taxonomic groups that may lend themselves most readily to that approach, depending on life histories of individual species. Most instances of early detection require dedicated personnel, but the effectiveness of dedicated personnel can often be multiplied substantially by public involvement. Involvement of the public in effective invasive species detection programs can lead to increased public support for increased prevention as well as for necessarily drastic eradication methods.

The landscape of invasive species perception, politics, and policy relevant to maintaining integrity of national parks of Hawaii and Pacific islands appears to be entering a phase of rapid change, and perhaps even "progress." The PACN should consider developing flexible approaches and protocols for invasive species early detection, with a view toward maximizing use of initially very limited money to catalyze improvements as needed.

Since the very recently introduced ohia rust (*Puccinia psidii*) could eventually prove to be the most destructive invasive species to be introduced to Hawaii in the past century, it may deserve special attention by the PACN. In the case of this invasive fungal disease organism, eradication is not possible. Rather the objective will be to coordinate monitoring efforts with border protection authorities to prevent additional genetic strains (that could increase the virulence, host range, and elevation range of the rust) from establishing in Hawaii.

NPS should consider that no other agency has the clear mandate for biodiversity protection that NPS has via the 1916 Organic Act. The threat of invasions is not so much a result of other agencies not doing their defined jobs as from major gaps in the system. NPS has a responsibility and an opportunity for championing invasive species issues through employee awareness and constructive interagency engagement. Some would say that NPS has in the past largely taken the "island" approach to management and has not generally engaged seriously in protection of biodiversity on an interagency basis, a point emphasized in a recent book by Thomas (2003). PACN may be uniquely positioned to lead the way nationally in reversing this perception.

INTRODUCTION

SCOPE OF TOPIC AREA

An invasive species is defined as an alien species whose introduction does or is likely to cause economic or environmental harm or harm, to human health (Executive Order 13112, 1999). For the purposes of the Pacific Island Network (PACN) Invasive Species workgroup, these include new and incipient vascular flora, fauna (vertebrate and invertebrate), and other life forms such as fungi, algae, or disease, in terrestrial, freshwater, and marine environments inside the parks. It also includes selected highly problematic species currently established outside PACN parks that have not yet reached park boundaries. Environmental effects of and monitoring programs for established invasive species are reviewed in other PACN workgroup reports (i.e., the vegetation, vertebrate fauna, and invertebrate reports). This report addresses issues regarding early detection of invasive species relevant for PACN national parks.

BACKGROUND

The challenge of effectively addressing the threat of invasive species to the National Park System

Ever-increasing transport of species of all kinds is breaking down biogeographical boundaries with profound consequences for biodiversity loss worldwide (Vitousek et al. 1997; Mooney and Hobbs 2000). When species are transported—intentionally or inadvertently—outside their original geographic ranges, many of them become established and spread. Some proliferate explosively, tending to displace native species in their new area of establishment. Evolving technology (e.g., containers) has increased shipping speeds and volumes, making our detection and interception strategies for stemming the flow of invasives in the United States very difficult to implement, and certainly inadequate (Campbell 2001; Loope and Howarth 2003). Given the seeds of catastrophic loss already planted and those yet to come, invasive species pose a highly significant threat to the biodiversity of the U.S. National Park System in the early decades of the 21st century (Wilcove et al. 1998). Moreover, global climate change is likely to exacerbate the problem by favoring invasive species over native species (Mooney and Hobbs 2000).

Preventing and combating invasions

Many serious biological invaders are permeating U.S. States and Territories and U.S.-affiliated islands and reaching even the relatively isolated and intact ecosystems of the national parks. Federal natural resource managers can potentially address invasive species issues in conjunction with local outreach efforts, working with agencies (federal, state, and local) and individuals in communities surrounding the parks and refuges for education, prevention, detection, and rapid response.

An NPS workshop in Ft. Collins, Colorado, 4–6 June 2002, produced useful guidelines for monitoring invasive plants in and near the national parks (Hiebert et al. 2002). Noteworthy innovations of the guidelines include the need to "work outside of park boundaries to manage at a landscape scale … [and] identify a buffer zone, which, when adequately managed in cooperation with partners, will more effectively accomplish invasive species management goals." Vascular plants comprise a highly visible group among invaders; however, although increasing attention is being given by public and private entities to the need for controlling plant invasions, almost no barriers to the movement of plant species by humans throughout the world

exist, including the United States. Approximately 20,000 species of vascular plants have proved invasive and damaging somewhere in the world (Randall 2002). U.S. federal noxious weed law (APHIS 2000) currently prohibits 91 species and five genera, most of which are well-documented threats to agriculture.

Insects and fungal diseases that attack trees are probably the most important invasive groups nationwide. The USDA Forest Service began working with the Animal and Plant Health Inspection Service (APHIS) of the U.S. Department of Agriculture (USDA) in the late 1980s to address invasive species threats associated with raw wood imports and solid-wood packaging materials (Tkacz et al. 1998). Nevertheless, Thomas Hofacker (staff entomologist, USDA Forest Service) sees forest health in the United States as broadly declining, with three to five new problematic insects or pathogens becoming established in this country each year, and with many tree species becoming "functionally extinct" (presentation at annual meeting of Entomological Society of America, San Diego, CA, December, 2001). Campbell (2001) believes this situation is at least partly due to the international system for regulating trade to prevent transport of potentially harmful organisms. This system places a huge burden of proof on countries wanting to protect their ecosystems from pests arriving through such pathways as raw wood and wood packing materials. Another important point is that the national and international quarantine system was designed to protect mainstream agriculture with little or no reference to the protection of natural areas from biological invasions (Campbell 2001; Baskin 2002).

In the United States, the agency primarily responsible for protecting our nation's borders from biological invasions was, until recently, USDA-APHIS. Because of growing recognition of the need to address this problem (e.g., the threat to forests from insects and diseases in raw wood and wood packaging material) and others, APHIS has begun to focus beyond its primary mandate of protecting mainstream American agriculture. Most of the large branch of APHIS responsible for protecting our borders from biological invasions at U.S. ports of entry (Plant Protection and Quarantine) was transferred to the Department of Homeland Security (DHS) in March 2003. How this move to a different government department with a different mandate will affect the protection of natural areas and biodiversity is not clear.

A 1993 report by the Congressional Office of Technology Assessment recognized many challenges the existing system faces to keep harmful non-indigenous species out of the United States (OTA 1993). For example, first-class mail within this country is a virtually unaddressed major pathway for transport of biological material (e.g., federal noxious weeds), protected against "unreasonable searches" by the Fourth Amendment to the U.S. Constitution (OTA 1993, p. 48–49). This is just one of many cases cited in the OTA report in which the current system gives invaders the edge.

Since publication of the OTA report, international treaties to facilitate the workings of the multilateral trading system have evolved (Werksman 2004). After years of trade negotiations, the World Trade Organization was established in 1995 and with it a treaty on sanitary and phytosanitary measures (FAO 2004). The treaty is managed by the Food and Agriculture Organization of the United Nations, which is responsible for implementing the International Plant Protection Convention. Some of the trade-promotion measures have not benefited invasive species prevention. For example, countries cannot legally exclude a potential pest in commerce unless they can clearly establish that a specific, credible threat exists through a risk-assessment process. Moreover, a country can require only the minimum treatment measures documented as effective in reducing risk. On the positive side, it can be said that the international system has

responded well to the threat of movement of pests in solid-wood packaging material and has produced largely excellent guidelines for regulating this pathway (FAO 2002).

Congress identified aquatic invasives as a growing national problem with the passing of the Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990, which was later amended with the inclusion of aquatic species in the Invasive Species Act of 1996. In recent years, the threat of aquatic invasive species has been increasingly addressed in education and outreach efforts as well as in U.S. Policy. However, what is still lacking are monitoring programs for established as well as incipient invasive species as pointed out in a recent Ocean Policy Report (U.S. Commission on Ocean Policy 2004). Progress was made with the establishment of the NOAA National Center for Research on Aquatic Invasive Species (NCRAIS) in 2003. In addition, a new program was initiated in 2002 by NOAA National Center for Coastal Ocean Science (NCCOS 2002). This program aims to inventory coastal marine species, create a warning system for regional managers, be an information node, conduct risk assessments for alien species, create an early detection and monitoring system as well as a Federal-State response plan. The Program started with a pilot project in Hawaii with the eventual goal of including information about coastal waters for U.S. States, Territories and U.S.-affiliated islands. Prevention of further introductions hinges in a large part on legal standards regulating the management of ballast water which has been implicated as the most important pathway for the introduction and spread of aquatic invasives.

Biological asymmetry and invasions

Not all regions of the world are equally susceptible to biological invasions; some regions primarily seem to be source areas. Called biogeographic asymmetry, this phenomenon has been widely recognized in marine and aquatic invasions (Vermeij 1991; Lodge 1993) although it is just as prevalent in terrestrial invasions. North American forests are particularly vulnerable to invasions of European and Asian insects (North American Forest Commission 2000). Many more plant-eating forest insects from Europe have successfully invaded North America (approximately 300) than have invaded Europe from North America (34; Nemiela and Mattson 1996). The decline of forest species of eastern North America caused by insects and pathogens, mainly from Asia (Campbell and Schlarbaum 2002), does not seem to be a reciprocal phenomenon. Very few native insects and diseases of North America are known to have become established in Asian forests.

Hawaii—the U.S. region most susceptible to biological invasions

Oceanic islands are well known to be especially vulnerable to invasive species. The Hawaiian Islands comprise one of the most isolated island groups in the world, with biological endemism at the species level approaching 100% for many native groups. Over all, Hawaii has approximately 10,000 endemic species (found nowhere else on earth besides Hawaii), out of a total biota of approximately 20,000 native species (Eldredge and Evenhuis 2003). Hawaii, with far above average vulnerability to invasions (Loope and Mueller-Dombois 1989), is also a major international hub of commerce. It is by far the U.S. region most damaged by invasions, with large numbers of and serious impacts from invasive vertebrates, invertebrates, and flowering plants (Loope 1998).

Nevertheless, Hawaii receives no special protection to prevent invasive species introductions. Border protection from foreign passengers' baggage and cargo at the Port of Honolulu is essentially identical to that at all other international ports in the U. S. (CFR, Chapter 7, 319.56-

8). Preventive actions are taken based primarily on an approved list of organisms for which specific legal authority is deemed to exist (James Kosciuk, Agriculture Liaison, Customs and Border Protection, DHS, Honolulu, Hawaii, personal communication, May 2004). Moreover, although Hawaii has better laws for preventing invasive species establishment than most states (OTA 1993), the Hawaii Department of Agriculture has little or no authority for protection from pests from foreign sources and receives limited funding (HDOA 2002). USDA-APHIS has a large program based in Hawaii for airport departure inspections to protect mainstream agriculture on the U.S. mainland from Hawaii's pests but no reciprocal measures for protecting Hawaii (OTA 1993). Clearly, the quarantine system is not protecting Hawaii from what Bright (1999) termed the "pathogens of globalization."

Hawaii has been one of the most unfortunate locations in the world as far as pest introduction is concerned, and its biodiversity and agriculture have suffered. The state is in the midst of an invasive species crisis affecting not only the archipelago's highly endemic biota, but also overall environmental and human health, and viability of its tourism- and agriculture-based economy (CGAPS 1996). The Invasive Species Specialist Group of the World Conservation Union (IUCN) recently developed a list of "100 of the World's Worst Invasive Species" (ISSG 2002); Hawaii has 47 of them.

Hawaii has roughly the same total number of nonnative arthropod species as the continental United States. McGregor (1973) speculated on the reason: "Although there is much greater diversity of crops and habitats within the continental United States, these are dispersed over a vastly larger land area. In Hawaii, where the overall diversity is less, the various habitats are more readily accessible from the principal port of entry." The more moderate and stable climate of Hawaii is also more favorable to an invading species than the climate in much of the United States. Furthermore, McGregor (1973) recognized this point in relation to agricultural quarantine: "(for insects and mites) in the period 1942–72 the rate of colonization per thousand square miles was 40 species, 500 times the rate of [the] continental United States." There is no evidence to indicate that this pattern has changed in the following 30 years.

More native species have been eliminated in Hawaii than anywhere else in the United States. Hawaii has lost about 8% of its native plant species and an additional 29% are at risk (Loope 1998). The state has lost 27 of its 73 historically known bird species and about 900 of 1,263 described land snail species (Loope 1998). With just 0.2% of the U.S. land area, Hawaii has about 30% of U.S. endangered species. Although habitat destruction has been an important cause of extinction and endangerment, the introduction and spread of invasive alien species has contributed in a major way in the past and is now the predominant cause of biodiversity loss in Hawaii.

Still, much biological richness is left in Hawaii's national parks, mostly at high elevations, but what is left is threatened by old, new, and future invasions. The invasive tree *Miconia calvescens* is an alarming and imminent threat. This large-leaved, shade-tolerant tree from tropical America has greatly reduced biodiversity over most of the rain forest area of Tahiti (Meyer 1996; Meyer and Florence 1996) and promises to do the same in Hawaii without major management intervention. Hawaii's national parks and Hawaii's NPS Exotic Plant Management Team are very much involved in interagency efforts to manage *M. calvescens* (Loope and Reeser 2001).

Good models for improved prevention for Hawaii exist in the largely successful preventive systems in place in New Zealand and Australia. In these countries the public accepts laws and

procedures, some involving a small loss of personal freedom, as the price that must be paid for protecting agriculture, forests, and native ecosystems. New Zealand has comprehensive biosecurity legislation and a highly rigorous border control system, utilizing trained dogs and X-ray technology (Baskin 2002; Loope 2004). Australia has a relatively successful plant screening system that has evaluated thousands of new plant introductions since its inception (Pheloung et al. 1999; Baskin 2002).

The stakes are high in Hawaii because of the state's world-class biota. No location in the world rivals Hawaii as a showcase for biotic evolution in isolation and adaptive radiation, not even the famed Galapagos archipelago (Williamson 1981). In Hawaii, the National Park Service emerged as a leader in conservation biology around 1970, turning apathy into action, and showed that extensive native ecosystems persisted at high elevations in the state. It has pioneered the use of fencing as a tool for sustained elimination of feral ungulates (Stone and Loope 1996), serious alien plant control within designated "special ecological areas" (Tunison and Stone 1992), pushing for better quarantine measures at airports and harbors (Reeser 2001), and drawing the line against *Miconia* and other invasive species. The National Park Service in Hawaii is well aware that it cannot rest on its laurels, however (Bryan Harry, NPS Pacific area director, personal communication, 2004).

Lag time often masks biological invasions on the U.S. mainland

Given unabated action of similar forces responsible for continued ecological degradation—habitat destruction and fragmentation, biological invasion, and cascading effects—biodiversity of mainland national parks is clearly at risk (Vitousek et al. 1997). Meanwhile, Hawaii comprises a useful testing ground where strategies to prevent and combat invasions can be applied, tested, and refined.

Lag time is an important and underappreciated phenomenon in invasion biology and tends to mask the pervasiveness of invasive species on the North American continent. For example, many nonnative insect and disease problems in eastern North America went unnoticed initially but have gathered momentum and become acutely problematic with time. For example, white pine blister rust (*Cronartium ribicola*), introduced with nursery stock from Europe, has been in this country for more than a century (Maloy 2001), but it is just now killing most of the whitebark pine (*Pinus albicaulis*) trees in the northern Rocky Mountains from Glacier National Park to Yellowstone and Grand Teton.

Likewise, hemlock woolly adelgid (*Adelges tsugae*), a tiny insect, also illustrates well the case of serious invasions, which are revealed as serious only gradually. Native to Asia, it reached the western United States in the 1920s and the eastern part of the country in the 1950s, but the conventional wisdom was that it attacked only cultivated hemlocks (Van Driesche and Van Driesche 2000). In the 1980s, reports surfaced of eastern hemlock death in Virginia, and the infestation has now become a huge problem from New England to North Carolina and is slowly spreading westward. This may be an invasion that could cause functional extinction of two hemlock species, eastern hemlock (*Tsuga canadensis*) and Carolina hemlock (*Tsuga caroliniana*).

Lag times are not always as long. Balsam woolly adelgid (*Adelges piceae*) has virtually eliminated Fraser fir (*Abies fraseri*) in Great Smoky Mountains National Park; it was first noted in the United States about 1950 and started attacking fir in the Smokies in the 1970s. Dogwood anthracnose (*Discula destructive*), first detected in the country in the 1970s, was reducing or

eliminating flowering dogwood (*Cornus florida*) in many eastern national park areas by the 1990s (Langdon and Johnston 1992).

Fast-moving and newly emergent invasive diseases deservedly get the most attention. Sudden oak death syndrome (caused by the fungus *Phytophthora ramorum*) is a high-visibility problem that popped up in 1995 in California and kills healthy trees within four months (Kliejunas 2001). For nearly a decade, the fungus in the United States had been confined to Pacific states. However, its chances of invading southeastern states, where numerous potentially susceptible oak (*Quercus*) species are ecological dominants, was learned to have been hastened in early 2004. At that time it was found that in spite of the best preventative efforts of APHIS, one large, infected nursery in Los Angeles had shipped susceptible plant material widely. An APHIS update reported, "As of June 15, *P. ramorum* has been confirmed in plants traced forward from the initially positive Los Angles County wholesaler at 118 sites in 16 states," including 11 states in the southeast (APHIS 2004).

How many more sleeper invasions have already been inoculated within ecosystems worldwide by the recent burgeoning of trade—involving diverse pathways from solid-wood packing and raw lumber to seed trade on the Internet? And how much are protective systems going to improve in the coming decades in addressing continuing inoculations? Change is going to depend more than anything on awareness.

Informing the public about invasive species

Entomologists Nemiela and Mattson, in a 1996 article in BioScience, stated (p. 751): "When the outrageous economic and ecological costs of the wanton spread of existing exotics and continued entry of new ones become common knowledge, it is inevitable that there will be a public outcry for actions to mitigate the potentially dire consequences." Whose responsibility is it to inform the public? One might conclude that the seriousness of the problem of biological invasions seems to be largely unrecognized in the consciousness of the American public. Among environmental concerns, clean air and clean water perhaps understandably seem to attract the most attention (since their direct effects are readily imagined). The reality is that biological invasions threaten much more than the integrity of natural ecosystems of national parks. They pose immense threats to the U.S. economy, agriculture, and forest resources, and to the public health and quality of life of U.S. citizens. Yet it seems that almost nowhere in American society is this message being conveyed effectively. Admittedly, the press reports with high frequency on specific invading species, but only rarely produces in-depth analyses relevant to the general problem of invasions (Nash 2004; Choo 2004).

National legislation protecting Pacific Island National Parks

"Sound laws and policies with respect to invasive species must address the role in commerce that many non-indigenous species play. Agriculture, horticulture, forestry, and other substantial commercial activities engage in extensive commerce in non-indigenous species. Everyday movement by people and commerce in nonliving objects may pose threats of accidental introduction of invasive species. No amount of law and policymaking with respect to natural areas will be successful if it ignores the interrelationship among natural and developed areas, and between those areas and human and commercial activity. The biological, psychological, and economic points have political implications: no law or policy that imposes substantial costs on commerce and development is likely to be adopted or to succeed unless the benefits are clear,

and unless the mechanisms are specified for implementation, enforcement, and measures of success or failure." (Miller and Gunderson 2004).

The difficulties in creating new laws designed to protect natural resources in a judicial culture that is designed to protect free trade were eloquently discussed in testimony regarding proposed federal legislation. From testimony of Mark R. Fox, Director of External Affairs, The Nature Conservancy, Hawaii Program, Field Hearing on Invasive Species, Subcommittee on National Parks:

"…there are formidable challenges to developing a truly effective prevention system—right up to and including the United State Constitution and the free market principles this nation is founded upon. For centuries this country has promoted the important notions of free trade and open borders to commerce.

"The Constitution's Commerce Clause (Art I., Sec. 8, Clause 3) and Supremacy Clause (Art VI, Clause 2) set that stage by giving Congress the authority to regulate commerce with other nations and between the states, and confirming that federal law is the supreme law of the land. In the area of pest prevention, the federal Plant Protection Act takes it a step further by specifically preempting states from being more restrictive than the federal government in regulating the movement of plants and plant products. (7 USC § 7756).The federal government is not so preemptive with respect to regulating the movement of animals, both terrestrial and aquatic.

"The differences in Hawaii state law regarding the introduction of plants and non-domestic animals (Hawaii Revised Statutes §§ 150A-6.1 and -6.2) directly reflect the preference for movement of plants through federal preemption of state regulatory regimes. Basically, Hawaii uses a black list (noxious weed list) approach to plants, and a white list approach to animals. What this means is that virtually all plants are allowed to be introduced to Hawaii unless on a very short noxious weed list (~80 identified plants). Conversely, no non-domestic animals are allowed entry into the state unless on one of two short approved lists.

"The State of Hawaii runs directly into federal preemption if it wishes to strengthen its statutes regarding plants or implement stricter state quarantine regulations. The only available choice is a long and laborious process of securing approval for heightened restrictions on a species-by-species basis from the Secretary of Agriculture. (7 USC § 7756(b)(2)(B)).

The challenges of U.S. alien species law were also summarized in a recent critical opinion (Miller 2004, pp. 164-166): "It is hard to imagine an area of law or policy more convoluted than the laws regarding harmful NIS [non-indigenous invasive species], yet with great legal and knowledge gaps on key issues. Even if lawyers might find the building blocks they need in current law to defend current or proposed government actions, no ecologist or policymaker would think a set of laws so fractured and designed for other purpose provides a wise foundation for NIS law and policy. Nor should any lawyer be satisfied with a legal framework that is so difficult to describe, understand, and apply. And no one, legislator, lawyer, scientist, or citizen, should be satisfied with the federal government's record thus far in preventing, identifying or responding to invasive species."

The National Park Service rises to the challenge

The issue of the threat of invasive alien species to natural areas obviously presents huge challenges, but there are many possibilities for working toward "solutions." A recent issue of BioScience presents an upbeat mix of ideas on promising approaches by knowledgeable

scientists (Dybas 2004). One such scientist's (Daniel Simberloff) presentation was entitled "We can win this war: The dangers of pessimism about introduced species." Another (David Lodge) is quoted as having made the observation that screening species for invasiveness is one of the essentials and that "we have or are developing the tools to do that. The management and policy tools, however, lag way behind." A third scientist (Ann Bartuska) expressed frustration over "how little we have done about dealing with … [the invasive species issue]—given how big it is, how clearly we know the impacts, how widespread it is, and how it touches everyone in one way or another.… We seem to have the political will and the public will to really take on fire [in wildland management] in a big way… but we don't seem to be able to do the same with invasive species." Her suggested solutions included "integrated vector management" and "an effective early detection rapid response system."

The National Park Service has special incentives for ramping up its efforts to address the invasive species issue. National parks and their ecosystems provide an excellent opportunity to bring the invasions message to the U.S. public. Parks have been identified in the past (originally by NPS Director George Hartzog in the early 1970s) as "miners' canaries" for U.S. environmental health and indeed can well serve as such for communication of the invasions message. Some regions and parks are much more susceptible to invasions than others, with some already showing substantial degradation. Parks in Hawaii, California, and Florida are especially affected by invasions. Those parks provide unfortunate but strong lessons to be learned by NPS employees and the general public. Those fortunate regions and parks that have up to now been less susceptible and have largely escaped damage by invasions can learn from their neighbors and anticipate threats posed by future invasions.

The 1916 NPS Organic Act states clearly that the national parks are to be kept "unimpaired for the enjoyment of future generations." The National Park Service now appears to be faced most ominously with massive impairment of the parks' natural resources by biological invasions from outside. One role for the National Park Service might be to accelerate its proactive role in informing its employees and the American public of the insidious nature of biological invasions. Another might be to include serious analyses of the importance of proactive quarantine systems suitable for regions at risk such as the Hawaiian Islands (Reeser 2002). Major breakthroughs in science, policy, and management will likely be needed to address the complex and important issue of biological invasions if substantial impairment of the parks is to be averted.

The NPS PACN is faced with the task of monitoring ecological change and impairment in a geographic region undergoing rapid invasion. A proactive role for PACN, working with partners and the public, in surveillance for detection of potential new invasions that can negatively affect park ecosystems is warranted. Opportunities for such proactive involvement by NPS would be enhanced by passage of legislation currently under consideration by the U.S. Congress – the Natural Resource Protection Cooperative Agreement Act (S. 1288) and the Public Land Protection and Conservation Act (S. 2598, 108th Congress). The purpose of the early detection is to allow opportunity for rapid response involving containment and possibly eradication by other agencies or by local partnerships. Involvement in this activity will allow NPS to be knowledgeable and involved in proactive management of invasive species, beginning with the prevention stage, rather than simply reacting.

Note: Much of the introductory background material above has been previously published in an article by L. L. Loope (2004a).

Monitoring Goals and Objectives

Primary goals of natural resource monitoring, as defined by the National Park Service Inventory and Monitoring Program (with the addition of a sixth goal for the PACN regarding resources with shared natural and cultural value), are to:

- Determine status and trends in selected indicators of park ecosystem(s) condition to allow managers to make better-informed decisions and to work effectively with other agencies and individuals for the benefit of park resources.
- Provide early warning of abnormal conditions of selected resources to help develop effective mitigation measures and reduce costs of management.
- Provide data to better understand the dynamic nature and condition of park ecosystems and to provide reference points for comparisons with other, altered environments.
- Provide data to meet certain legal and Congressional mandates related to natural resource protection and visitor enjoyment.
- Provide a means of measuring progress towards performance goals.
- Provide data to better understand, protect, and manage important resources that share cultural and natural value.

The identification and monitoring of Vital Signs, or ecosystem elements selected to provide the most information on ecosystem health, is an integral part of this program. Early detection of invasive species has been selected by the PACN as a Vital Sign.

The goal of the Invasive Species workgroup is to assist the Pacific Island Network in evaluating how it can best utilize its monitoring program to work proactively with its partners to prevent, detect, and eradicate new and incipient invasions. Specific objectives include:

- Incorporating NPS monitoring into a statewide collaborative early detection effort for new and incipient species;
- Identifying monitoring methods as needed for evaluating the effectiveness of existing and potential prevention techniques. For instance, weed risk assessments, quarantines/inspections, ballast water flushing policies, and aquarium and horticulture trade restrictions;
- Assisting in documenting the effectiveness of management efforts on species and ecosystems;
- Assisting in determining the status and trends of invasions over time and space;
- Assisting (via assuring use of appropriate methods) to determine distribution, abundance, or invasive characteristics of species;

MANDATES, POLICY, AND LEGISLATION

As a federal agency, the NPS operates under a hierarchy of legislative mandates including federal laws, executive orders, Department of the Interior and NPS policies and directives, as well as county, state, commonwealth, and territorial regulations (Table 1). Management of submerged resources is complicated by jurisdictional or administrative issues that are often managerially more challenging than similar issues on land. These complexities require the NPS

to cooperate with numerous and often overlapping federal and local agencies to achieve its objectives.

Table 1. Mandates, policy, and legislation pertaining to invasive species.

Mandate	Policy or legislation
I & M Program	Natural Resources Challenge (1999)
International Conventions and Treaties	International Plant Protection Convention (1952, ratified 1972, amended 1987)
	Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement 1995)
Federal Policies and Legislation	Plant Quarantine Act (1912)
	Federal Seed Act (1939)
	Federal Insecticide, Fungicide, and Rodenticide Act (1947)
	National Environmental Protection Act (1970)
	Endangered Species Act of (1973)
	Federal Noxious Weed Act (1974)
	Nonindigenous Aquatic Nuisance Prevention and Control Act (NANPCA 1990)
	Hawaii Tropical Forest Recovery Act (1992)
	Alien Species Prevention and Enforcement Act (1992)
	Federal Plant Pest Act (1957; amended in 1994
	National Invasive Species Act (1996)
	Lacey Act (1900; amended in 1998)
	Plant Protection Act (2000)
	Brown Tree Snake Control and Eradication Act (2004)
Pending Legislation	The Natural Resource Protection Cooperative Agreement Act: (H.R. 4294, 109th Congress)
	The Public Land Protection and Conservation Act (S. 2598, 108th Congress)
	The Hawaii Invasive Species Prevention Act (H.R. 3468, 109th Congress)
Executive Orders	Executive Order 13112 (Feb. 1999)
NPS Management Policies	Plant and Animal Population Management Principles (2001 NPS Management Policies, section 4.4.1.1)
	Removal of Exotic Species Already Present (2001 NPS Management Policies, section 4.4.4.2)

INVENTORY & MONITORING PROGRAM (NATURAL RESOURCE CHALLENGE)

The Natural Resource Challenge (NRC), initiated in 1999, is an action plan for preserving natural resources through the NPS. The NRC assisted NPS in establishing 32 I&M networks, which includes 270 national parks, monuments, sites, etc. These lands were grouped into networks based on geographic and natural resource characteristics. The I&M Program is designed to first complete basic inventories of natural resources in parks, on which to base long-term monitoring efforts. Monitoring programs are based on critical parameters (Vital Signs)

within each network to incorporate into natural resource management and decision-making. "Vital Signs are measurable, early warning signals that indicate changes that could impair the long-term health of natural systems" (NPS 2003).

INTERNATIONAL CONVENTIONS AND TREATIES

Unless otherwise stated, the following information was obtained from the National Agricultural Library for the National Invasive Species Council.

- **International Plant Protection Convention** (1952, U.S. ratified 1972, amended 1987): This convention pertains to pests of plants or plant products ("any form of plant or animal life, or any pathogenic agent, injurious or potentially injurious to plants or plant products"); and quarantine pests involved with international trade ("pest of potential national economic importance to the country endangered thereby and not yet present there, or present but not widely distributed and being actively controlled"). It creates an international system to prevent the spread and introduction of plant and plant product pests, premised on exchange of phytosanitary certificates between importing and exporting countries' national plant protection offices. Parties have national plant protection organizations established according to the Convention. These organizations have authority in relation to quarantine, risk analysis and other measures required to prevent the establishment and spread of all invasive alien species that (directly or indirectly) are pests of plants. Parties agree to cooperate on information exchange and development of International Standards for Phytosanitary Measures.
- **Agreement on the Application of Sanitary and Phytosanitary Measures** (SPS Agreement) (1995): The SPS agreement is a supplementary agreement to the World Trade Organization Agreement. It pertains to pests, diseases, disease-carrying organisms, or disease-causing organisms transported through trade or commerce. The agreement provides a uniform interpretation of the measures governing safety and plant and animal health regulations, and is applicable to all sanitary and phytosanitary measures directly or indirectly affecting international trade. Sanitary and phytosanitary measures are defined as "any measure applied a) to protect animal or plant life or health within (a Members' Territory) from entry, establishment or spread of pests, diseases, disease carrying organisms; e) to prevent or limit other damage within the (Members Territory) from the entry, establishment or spread of pests".

  This treaty is managed by the U.N. Food and Agricultural Organization, which is also responsible for implementing the International Plant Protection Convention (IPPC). According to these two treaties, countries cannot protect themselves from a pest unless they can clearly establish that a specific, credible threat exists through a risk assessment process. The treaties establish the point at which a country can require only the minimum treatment measures documented as effective in reducing risk to an acceptable level. This process appears on the surface to be geared toward facilitating free trade at the expense of environmental (if not agricultural) concerns. Some would say that it's not only the quantities and speed of trade but also that nations have agreed to tie the hands of those protecting their borders from new introductions. The U.S. and its trading partners established and willingly bought in to this system, and it is a system all countries must work with. Change in the status quo is likely to occur only with a melding of sound science and political will. New Zealand and Australia seem to have found a means of

fully supporting and complying with the treaty while accommodating what seem to be excellent systems for protecting forests and native ecosystems. Fortunately, national and international efforts are underway to resolve the challenges of accommodating both free trade and environmental protection (e.g., an International Plant Health Risk Analysis Workshop, Niagara Falls, Canada, October 24-28, 2005, organized by the IPPC and the Canadian Food Inspection Agency).

- International Ballast Water Management Convention. *Note* – this convention has not yet entered into force. From the International Conference on Ballast Water Management (9-13 February 2004): "A new international convention to prevent the potentially devastating effects of the spread of harmful aquatic organisms carried by ships' ballast water has been adopted by the International Maritime Organization (IMO), the United Nations agency responsible for the safety and security of shipping and the prevention of marine pollution from ships. The Convention will require all ships to implement a Ballast Water and Sediments Management Plan. All ships will have to carry a Ballast Water Record Book and will be required to carry out ballast water management procedures to a given standard. Existing ships will be required to do the same, but after a phase-in period." This Convention will enter into force 12 months after ratification by 30 States, representing 35 per cent of world merchant shipping tonnage.

FEDERAL POLICIES AND LEGISLATION

- **Plant Quarantine Act** (1912): Relevant aspects of this act pertain to intentional and unintentional introduction of plants (field-grown florists' stock, trees, shrubs, vines, etc.) and plant diseases and pests. Provisions of the act give USDA-APHIS authority to regulate importation and interstate movement of nursery stock and other plants that may carry harmful pests and diseases. The act preempts state quarantines in interstate commerce.
- **Federal Seed Act** (1939): Relevant aspects of the Federal Seed Act of 1939 pertain to the intentional introduction of seeds through trade. Provisions of the act require accurate labeling and purity standards for seeds in commerce and prohibit importation and movement of adulterated or misbranded seeds.
- **Federal Insecticide, Fungicide, and Rodenticide Act** (1947): Relevant aspects of this act pertain to intentional introduction of biological control agents. Provisions of the act give the USEPA authority to regulate importation and distribution of substances, including organisms, that are intended to function as pesticides.
- **National Environmental Protection Act** (1970): Relevant aspects of this act pertain to intentional introductions, related to major federal actions, of non-native species posing harm to the environment. Provisions of the act require federal government agencies to consider the environmental effects of their actions through preparation of environmental impact statements; effects of non-native species, if harmful to the environment, must be included in the EIS. However, it should be noted that USDA-APHIS may approve and issue permits for importing nonindigenous species following preparation of an environmental assessment rather than an environmental impact statement (permits for importing nonindigenous species into containment facilities or interstate movement between containment facilities are excluded from NEPA requirements).

- **Endangered Species Act of (1973**) The purpose of the endangered species act is to protect endangered and threatened species. When nonnative invasive species threaten endangered species, this Act could be used as basis for their eradication by the Department of Interior (USFWS) or by the Department of Commerce (NOAA).
- **Federal Noxious Weed Act** (1974): The relevant aspects of the act pertain to intentional introductions (import) of noxious weeds. Noxious weeds are defined as "any living stage (including, but not limited to, seeds and reproductive parts) of any parasitic or other plant of a kind, or subdivision of a kind, which is of foreign origin, is new to or not widely prevalent in the United States, and can directly or indirectly injure crops, other useful plants, livestock, or poultry or other interests of agriculture, including…the fish and wildlife resources of the United States or the public health." Provisions of this act prohibit the import or entry of any noxious weed identified in regulation into or through the United States; authorize APHIS to restrict the introduction and spread of non-native noxious weeds through port-of-entry and follow-up activities; and authorizes permanent restrictions and emergency regulations. Except for Section 2814, which pertains to management of undesirable plants on federal lands, this act is superseded by the Plant Protection act of 2000.
- **Nonindigenous Aquatic Nuisance Prevention and Control Act** (NANPCA 1990): This act aims to prevent and control infestations of the coastal inland waters of the United States by non-native aquatic nuisance species. The act established the Aquatic Nuisance Species Task Force to identify areas threatened/not threatened by ballast water, assess the threat to the ecological characteristics and economic uses of U.S. waters, determine the need for controls on vessels entering U.S. waters, and identify and evaluate approaches for reducing the risk of adverse consequences associated with intentional introduction of aquatic species. The task force also directs the Coast Guard to issue regulations to prevent the introduction and spread of aquatic nuisance species into the Great Lakes through ballast water and directs the Corps of Engineers to develop a program of research and technology to control zebra mussels in and around public facilities and make available information on control methods. NANPCA was reauthorized and expanded by the National Invasive Species Act of 1996
- **Hawaii Tropical Forest Recovery Act** (1992): This act pertains to unintentional and intentional introductions of non-native species. Provisions of the act authorize the Secretary of Agriculture and USFS to establish biological control agents for non-native species, and creates a task force to develop an action plan to promote public awareness of the harm caused by introduced species and develop management recommendations for the protection of Hawaii's native biota from non-native species.
- **Alien Species Prevention and Enforcement Act** (1992): This act pertains to plants and animals whose shipment is prohibited under 18 U.S. Code 42;43, or the Lacey Act and plants or plant matter whose shipment is prohibited under the Federal Plant Pest Act or Plant Quarantine Act. Provisions of this act make illegal the shipment of certain categories of plants and animals through the U.S. mail.
- **Federal Plant Pest Act** (1957; amended in 1994): This act pertains to unintentional and intentional introduction, and importation of plant pests. It should be noted that packing and shipping materials, as well as containers and ships are unregulated.

- **National Invasive Species Act** (1996): This act reauthorizes and expands the Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990. Expanded provisions: amended the previous act to mandate regulations for preventing introduction and spread of aquatic nuisance species into the Great Lakes via ballast water; authorized funding for research on aquatic nuisance species prevention and control; required the ballast water management program to demonstrate technologies and practices to prevent nonindigenous species from being introduced; modified composition of Aquatic Nuisance Species Task Force; and required the Task Force to develop and implement a comprehensive program to control the brown tree snake in Guam.
- **Lacey Act** (1900; amended in 1998): This act pertains to the intentional introduction and trade of species injurious to human beings or resources. The act prohibits the import of a list of designated species as well as "other vertebrates, mollusks, and crustacea that are injurious to human beings, to the interests of agriculture, horticulture, forestry, or to wildlife or the wildlife resources of the United States". It also declares importation or transportation of any live wildlife as injurious and prohibited, except as provided for under the Act. However, the act allows import of almost all species for scientific, medical, education, exhibition, or propagation purposes.
- **Plant Protection Act** (2000): This act pertains to the unintentional and intentional introduction of plants and plant material, and plant pests. It replaces the Federal Noxious Weed Act and many other USDA-APHIS Plant Protection Authorities. It consolidates and modernizes all major statutes pertaining to plant protection and quarantine (Federal Noxious Weed Act, Plant Quarantine Act); permits APHIS to address all types of weed issues; increases the maximum civil penalty for violation; and authorizes APHIS to take both emergency and extraordinary emergency actions to address incursions of noxious weeds.
- **Brown Tree Snake Control and Eradication Act** (2004): This act pertains to unintentional and intentional introduction of the Brown Tree Snake. To provide for the control and eradication of the brown tree snake on the island of Guam and the prevention of the introduction of the brown tree snake to other areas of the United States. The Secretaries shall provide funds to support brown tree snake control, interdiction, research, and eradication efforts carried out by the Department of the Interior and the Department of Agriculture, other Federal agencies, States, territorial governments, local governments, and private sector entities. Funds may be provided through grants, contracts, reimbursable agreements, or other legal mechanisms available to the Secretaries for the transfer of Federal funds.

PENDING LEGISLATION (2005-06)

- **The Natural Resource Protection Cooperative Agreement Act**: (H.R. 4294, 109th Congress): The purpose of this act is to authorize the Secretary of the Interior to enter into cooperative agreements to protect natural resources of units of the National Park System through collaborative efforts on land inside and outside of units of the National Park System, and for other purposes.
- **The Public Land Protection and Conservation Act** (S. 2598, 108th Congress): This act will protect, conserve, and restore public land administered by the Department of the

Interior or the Forest Service and adjacent land through cooperative cost-shared grants to control and mitigate the spread of invasive species, and for other purposes.

- **The Hawaii Invasive Species Prevention Act** (H.R. 3468, 109th Congress): The purpose of this act is to recognize the unique ecosystems of the Hawaiian islands and the threat to these ecosystems posed by non-native plants, animals, and plant and animal diseases, to require the Secretary of Agriculture and the Secretary of the Interior to expand Federal efforts to prevent the introduction in Hawaii of non-native plants, animals, and plant and animal diseases, and for other purposes. In particular this bill would: (1) Mandate federal quarantine protection for the State of Hawaii to prevent the introduction of invasive species, including a system of post-arrival protocols for all passengers and cargo; (2) Allow for federal enforcement of State quarantine laws; (3) Establish an expedited review process for the State of Hawaii to impose restrictions on the movement of invasive species or diseases that are in addition to federal restrictions; (4) Allow the State of Hawaii to impose limited emergency restrictions upon the introduction or movement of a pest or disease.

EXECUTIVE ORDERS

Executive Orders are official documents, through which the President of the United States manages the operations of the Federal Government.

- **Executive Order 13112** (Feb. 1999): This Order directs all federal agencies to address invasive species concerns and refrain from actions likely to increase invasive species problems. It also creates an interagency Invasive Species Council and calls for a National Invasive Species Management Plan to better coordinate federal agency efforts. The Order defines invasive species as "any species, including its seeds, eggs, spores, or other biological material capable of propagating that species, that is not native to that ecosystem."

NPS MANAGEMENT POLICIES

NPS management policies are designed to provide clear and continuously updated information on policies and required or recommended actions, as well as any other information that will help manage parks and programs effectively. Management policies pertaining to invasive species include the following:

- **Plant and Animal Population Management Principles** (2001 NPS Management Policies, section 4.4.1.1.) This policy specifies that parks should work with partners to 55manage species, which cross park boundaries as well as those found outside parks. It also develop cooperative strategies for maintaining or restoring these populations in the parks
- **Removal of Exotic Species Already Present** (2001 NPS Management Policies, section 4.4.4.2.) This management concept prioritizes management and eradication of exotic species already present within a park. High priority is to be given to managing exotic species that have, or potentially could have, a substantial impact on biological or cultural resources and that can reasonably be expected to be successfully controllable.

REGIONAL CONTROLS AND REGULATIONS

Table 2: Regional Controls and Regulations pertaining to invasive species.

Region	Regulation
State of Hawaii	Seed Rules including Noxious Weed Seeds (Hawaii Administrative Rules, Title 4, Department of Agriculture, Subtitle 6, Division of Plant Industry, Chapter 67)
	Noxious Weed Rules (Hawaii Administrative Rules, Title 4, Department of Agriculture, Subtitle 6, Division of Plant Industry, Chapter 68)
	Pests for Control or Eradication (Hawaii Administrative Rules, Title 4, Department of Agriculture, Subtitle 6, Division of Plant Industry, Chapter 69A)
	Plant and Non-Domestic Animal Quarantine Plant Import Rules (Amendment) (Hawaii Administrative Rules, Title 4, Department of Agriculture, Subtitle 6, Division of Plant Industry Chapter 70)
	Plant and Non-Domestic Animal Quarantine, Non-Domestic Animal and Microorganism Import Rules (Hawaii Administrative Rules, Title 4, Department of Agriculture, Subtitle 6, Division of Plant Industry Chapter 71)
	Plant and Non-Domestic Animal Quarantine Plant Intrastate Rules (Amended) (Hawaii Administrative Rules, Title 4, Department of Agriculture, Subtitle 6, Division of Plant Industry Chapter 72)
	Plant and Non-Domestic Quarantine Plant Export Rules (Hawaii Administrative Rules, Title 4, Department of Agriculture, Subtitle 6, Division of Plant Industry Chapter 73)
	Introduced Freshwater Fishes (Hawaii Administrative Rules, Title 13, Department of Land and Natural Resources, Subtitle 4, Fisheries, Part VI Protected Freshwater Fisheries Resources, Chapter 99)
	Ballast Water Management (a Bill for an Act. House Bill No. 1212)
Guam	Coqui frog prevention (2004)
	Quarantine law
CNMI	Plant Quarantine
	Animal Quarantine
American Samoa	**Animal Rules**
	Compliance with animal rules required (Rule 24.0305)
	Domestic animal import permit (Rule 24.0306)
	Ruminants, swine, dogs and cats, poultry, and meat (Rule 24.0307)
	Cattle test certificates required (Rule 24.0308)
	Inspection of animals at port of entry (Rule 24.0311)
	Articles accompanying animals (Rule 24.0312)
	Animals traveling through (Rule 24.0313)
	Importation of animals by aircraft (Rule 24.0314)
	Nondomestic animals-Prior permission (Rule 24.0315)
	Department of agriculture animal importation (Rule 24.0316)
	Dog and cat importation prohibited- Exceptions (Rule 24.0317)
	Miscellaneous pet importation prohibited (Rule 24.0318)
	Keeping on aircraft and vessels (Rule 24.0319)
	Domestic animal importation (Rule 24.0320)
	Plant Rules
	Compliance with plant, fruit, and vegetable rules required (Rule 24.0325)
	Fruits and vegetables-Fruit fly and citrus disease restrictions (Rule 24.0326)
	Prohibited plants, plant parts, and seeds (Rule 24.0327)
	Permit for plant material importation (Rule 24.0328)
	Certification of plants and materials (Rule 24.0329)
	Examination at entry of plants, parts, and products (Rule 24.0330)
	Department of agriculture importation (Rule 24.0331)
	Emergency quarantine rules (Rule 24.0332)

	Special Rules
	Refuse disposal by vessels and aircraft (Rule 24.0335)
	Ratguards on vessels (Rule 24.0336)
	Aircraft spraying (Rule 24.0337)
	Packing material prohibited- Exceptions (Rule 24.0338)
	Feed and materials-Prohibited when –Certification (Rule 24.0339)

State of Hawaii

- **Seed Rules including Noxious Weed Seeds** (Hawaii Administrative Rules, Title 4, Department of Agriculture, Subtitle 6, Division of Plant Industry, Chapter 67): these rules implement requirements to establish criteria for seed analyses and certification. Certification means the process of regulating the production and labeling of seed to comply with the standards of the official seed-certifying agency of that state.
- **Noxious Weed Rules** (Hawaii Administrative Rules, Title 4, Department of Agriculture, Subtitle 6, Division of Plant Industry, Chapter 68): these rules establish criteria for designation, control or eradication of noxious weeds.
- **Pests for Control or Eradication** (Hawaii Administrative Rules, Title 4, Department of Agriculture, Subtitle 6, Division of Plant Industry, Chapter 69A): these rules govern the criteria and procedures for designation of pests for control or eradication programs on public or private property other than dwellings in the state.
- **Plant and Non-Domestic Animal Quarantine Plant Import Rules** (Amendment) (Hawaii Administrative Rules, Title 4, Department of Agriculture, Subtitle 6, Division of Plant Industry Chapter 70): these rules restrict or prohibit the importation of specific plants to minimize the risk of introduction and establishment of insects, diseases, and other pests that would be highly destructive to Hawaii's agricultural industries and forest resources.
- **Plant and Non-Domestic Animal Quarantine, Non-Domestic Animal and Microorganism Import Rules** (Hawaii Administrative Rules, Title 4, Department of Agriculture, Subtitle 6, Division of Plant Industry Chapter 71): These rules restrict the importation of specific non-domestic animals that are detrimental to agriculture, horticulture, and aquacultural industries, natural resources and environment of Hawaii.
- **Plant and Non-Domestic Animal Quarantine Plant Intrastate Rules** (Amended) (Hawaii Administrative Rules, Title 4, Department of Agriculture, Subtitle 6, Division of Plant Industry Chapter 72): these rules restrict or prohibit the interisland transport of plant pest and their plant host to prevent the spread and establishment of plant pest detrimental to agriculture, horticultural industries and forest lands on uninfested islands of the state.
- **Plant and Non-Domestic Quarantine Plant Export Rules** (Hawaii Administrative Rules, Title 4, Department of Agriculture, Subtitle 6, Division of Plant Industry Chapter 73): These rules provide export plant and plant products inspectional and disinfestations treatment services that meet the requirements of the state or country of destination.
- **Introduced Freshwater Fishes** (Hawaii Administrative Rules, Title 13, Department of Land and Natural Resources, Subtitle 4, Fisheries, Part VI Protected Freshwater Fisheries Resources, Chapter 99): These rules provide export plant and plant products inspectional

and disinfestations treatment services that meet the requirements of the state or country of destination.

- **Ballast Water Management (**a Bill for an Act. House Bill No. 1212) Prohibits commercial passenger vessels from releasing specified substances into the marine waters of the state.

Guam

- **Coqui frog prevention**. In December 2004, the Guam Department of Agriculture revised its import protocols of live plants from Hawaii to prevent the spread of Coqui frogs (*Eleutherodactylus coqui*) to Guam. The protocols are as follows: Commercial Shipments - Plants shipped to Guam must be either heat treated using a water drench at 113ºF for 5 minutes or treated using a 16% citric acid solution. Shipment must be accompanied by a Phytosanitary Certificate issued by Hawaii Department of Agriculture attesting to compliance with above requirements and that shipment has also been inspected for all other pests of quarantine concern to Guam; Phytosanitary Certificate must indicate origin of plants. Sea shipping containers must be routed unopened to the Plant Inspection Station where contents will be inspected as per normal procedures which will include the shutting down of refrigeration unit to allow warm up and overnight audio inspection for calling coqui frogs. Containers may be quarantined for several days and nights for observation and inspection. Personal Shipments - All personal shipments are routed to the Plant Inspection Station where they are inspected and washed; other treatments may be used if necessary.

- **Quarantine law**: Guam's quarantine law is designed to protect residents and pets from potential serious health problems associated with the presence and spread of rabies. Success of the quarantine program is dependent on maintaining isolation of your pet from other animals for the required quarantine period. Title 10 Guam Code Annotated Chapter 34 Article 3 governs importation of dogs, cats and other carnivores into Guam. This law states that these animals are required to complete a 120-day confinement in an approved Commercial Quarantine Facility. If specific pre-arrival and post-arrival requirements are met, animals may qualify for the alternate 30-day quarantine. Public Law 27-84. This law provides for a five (5) day or less quarantine program for pets entering Guam, provided that requirements are met prior to entry, by amending ss34302(b) of Title 10, Guam Code annotated. Ss(b)(2) is added to ss34302 of Division 2 of Title 10 of the Guam Code Annotated.

  Exemptions: Animals originating from the British Isles, Australia, New Zealand and Hawaii on direct flights to Guam may be exempt from quarantine requirements after meeting shipping requirements. Users of service dogs, belonging to a Federal or State Government Agency, and guide dogs may wish to have their animals qualified to allow them to enter Guam without being held in quarantine at the Commercial Quarantine Facility. All other dogs and cats, regardless of purpose or health status are required to comply with Guam's quarantine law.

Commonwealth of the Northern Mariana Islands (CNMI)

- **Plant Quarantine**: In order to import plants from the United States a permit must first be obtained from the Plant Industry Division, Department of Lands and Natural Resources.

The cost of the permit is $1.00. A phytosanitary certificate must be obtained at the point of origin of the plant and accompany the plant and the permit when it enters the CNMI. Inquiries should be made to the Plant Industry Division when seeking to bring in plants from other areas. U.S. Department of Agriculture regulations are followed and plants are admitted on a case by case basis.

- **Animal Quarantine**: The Commonwealth is free of Rabies. An entry permit is required for all animals. The cost is $5.00 and is non-refundable. Dogs and cats are admitted without quarantine if shipped directly from Hawaii, Guam or Australia. Dogs or cats from the mainland United States must undergo a 120 day quarantine in Hawaii, Guam or Saipan. Quarantine facilities are limited on Saipan and must be reserved at least 60 days in advance of the shipment of the animal. Daily kennel rental is $1.50 for cats; dogs less than 30 pounds, $1.50; dogs between 30 - 70 pounds, $1.75; dogs over 70 pounds, $2.00. Rabies shots are required; parvovirus is recommended. Guam, Saipan and Honolulu are endemic for heartworm. Animals should begin treatment 1 to 2 months prior to entering these areas. A private veterinary services is available on Saipan.

American Samoa

The objective of the Plant and animal Quarantine Section, Department of Agriculture, is to prevent the introduction of international plant pests and diseases and the introduction of invasive species of plants and animals from entering the Territory of American Samoa at the Port of Entries, the airport and seaport.

Under the American Samoa Administrative Code the following rules apply to the quarantine of pets, agricultural products and animals:

Animal Rules

- **Compliance with animal rules required** (Rule 24.0305). No person, firm, or corporation shall import or bring into American Samoa any animals, domestic or otherwise, except in accordance with the provisions of this chapter; nor shall any animals be handled or moved after physical entry into American Samoa and before final release from quarantine or any other form of governmental restriction or detention except in compliance with this chapter. History: Ex. Ord. 1, eff Jan 55, Plant and Animals Quar. Regs. Part 2 § 1.
- **Domestic animal import permit** (Rule 24.0306). For domestic animals of all kinds intended for importation from any part of the world, the importer shall first obtain a permit from the department of agriculture, which shall be presented to the chief quarantine officer or his representative at the port of entry at the time of importation. Animals will not be eligible for entry if shipped from any foreign port other than that designated in the permit. The import permit fee for all domestic animals shall be $1 per permit. History: Ex. Ord. 1. eff Jan 55, Plant and Animal Quar. Regs. Part 2 § 2; and Rule 6-84. eff I May 84. (part).
- **Ruminants, swine, dogs and cats, poultry, and meat** (Rule 24.0307).

  (a) No ruminants or swine or fresh, chilled, or frozen beef, veal, mutton, lamb, or pork may be imported from any country where rinderpest, foot-and-mouth disease, hog cholera, or swine plague is known to exist, and no permits will be issued for such importation.

(b) All ruminants and swine offered for importation from any part of the world, except as provided in 24.0309, shall be accompanied by a certificate of a salaried veterinary officer or other competent authority of the government of the place of origin, stating that such animals have been kept in that place at least 60 days immediately preceding the date of movement from there and that the country, during such period, has been entirely free from foot-and-mouth disease, rinderpest, contagious pleuropneumonia, and surra; provided, however, that in the case of sheep, goats, and swine, the certificate, insofar as it relates to contagious pleuropneumonia, may specify freedom from such disease of the district of origin only. For domestic swine, the certificate shall also show that for 60 days immediately preceding the date of movement from the premises or origin, no erysipelas has existed on the premises of origin or on adjoining premises.

(c) All poultry and poultry products, except as provided in 24.0309, offered for importation from any part of the world, shall be accompanied by a certificate of a salaried veterinary officer of the government of the place of origin stating that such poultry and their flock or flocks of origin were inspected on the premises of origin immediately before the date of movement from such place and that they were then found to be free of evidence of pullorum disease and other communicable disease, and that as far as it has been possible to determine, no case of European fowl pest (fowl plague) or Newcastle disease (avian pneumoencephalitis) occurred in the locality or localities where the poultry were kept during such period.

(d) All dogs and cats offered for importation from any part of the world, except as provided in 24.0306, shall be accompanied by a satisfactory certificate of a salaried veterinary officer or other competent authority of the government of the place of origin stating that the animal has been given a prophylactic dose of antirabies vaccine no later than 30 days prior to date of arrival at the port of entry.

- **Cattle test certificates required** (Rule 24.0308). Except as provided in 24.0306, all cattle offered for importation from any part of the world shall be accompanied by a satisfactory certificate of a salaried veterinary officer or other competent authority of the government of the place of origin stating that the animals have been tested for tuberculosis and tuberculosis, with negative results within 30 days of the date of their exportation. The certificate shall give the dates and place of testing, names of the consignor and consignee, and a description of the cattle with breed, ages, and markings.
- **Inspection of animals at port of entry** (Rule 24.0311). All animals offered for importation from any part of the world shall be inspected at the port of entry and such animals found to be free from disease, and not to have been exposed to contagious disease, will be admitted subject to the other provisions of this chapter. Animals found to be affected with a contagious disease or to have been exposed thereto shall be refused entry and unless returned to the country of origin, shall be destroyed. Such portions of the transporting vessel and of its cargo as have been exposed to those animals or their emanations shall be disinfected in such manner as may be considered necessary by the inspector in charge at the port of entry before the cargo is allowed to land.
- **Articles accompanying animals** (Rule 24.0312). No litter or manure, fodder or other aliment, nor any equipment such as boxes, buckets, ropes, chains, blankets, or other things

used on or about animals governed by this chapter shall be landed from any vessel except under such restrictions as the inspector in charge at the port of entry directs.

- **Animals traveling through** (Rule 24.0313). Masters of vessels transporting animals not intended for importation into American Samoa shall comply with all restrictions and requirements deemed necessary by the inspector in charge at the port of entry to prevent entry of such animals into American Samoa.
- **Importation of animals by aircraft** (Rule 24.0314). No animals, either domestic or otherwise, shall be imported or brought into American Samoa by airplane, except that they may be imported by that means when the importer has received prior permission in writing from the Governor to do so and only when the importer complies with all other requirements.
- **Nondomestic animals-Prior permission** (Rule 24.0315). Animals other than domestic may be imported or brought into American Samoa only when the importer has received prior permission in writing from the Governor and when the importer complies with any special rules that may be imposed.
- **Department of agriculture animal importation** (Rule 24.0316). Nothing in this chapter shall be construed to prevent the department of agriculture from making importations of animals from any part of the world for breeding or other purposes, provided that suitable and adequate quarantine safeguards are maintained.
- **Dog and cat importation prohibited- Exceptions** (Rule 24.0317). Importation of dogs or cats into American Samoa is strictly prohibited; except: (1) importation of dogs or cats into American Samoa is permitted from the following rabies free areas: Hawaii, New Zealand, and Australia, subject to terms and conditions from time to time established by the department of agriculture in response to changing local and foreign problems of disease control;

  (2) importation of domestic dogs and cats into American Samoa is also permitted from the continental United States, -the Territory of Guam, and the Pacific Island Trust Territories subject to terms and conditions from time to time established by the department of agriculture in response to changing local and foreign problems of disease control. Included therewith, with regard to dogs or cats from the continental United States, Guam, or Trust Territories, is mandatory quarantine in the state of Hawaii for a period to be determined by the department of agriculture;

  (3) importation of domestic dogs and cats into American Samoa from Western Samoa shall be entirely subject to the terms and conditions of entry then in existence; the director of agriculture at any time is empowered to entirely prohibit entry of dogs or cats from Western Samoa or to allow entry upon such conditions as he then sees fit;

  (4) the director of agriculture shall, due to the unique and delicate nature of disease control on a small island, propagate from time to time and as he sees fit, terms and conditions of entry into American Samoa of domestic dogs and cats. The director shall at all times make available to the public a copy of this section and the terms and conditions of entry aforementioned; furthermore, copies of both shall be provided to the department of manpower resources as well as to all employers hiring off-island personnel at their request, as well as to all air carriers doing business in the territory;

(5) compliance with the provisions of this section and the terms and conditions of entry shall be the sole responsibility of the dog or cat owner. Any dog or cat arriving in American Samoa without prior, complete compliance with the terms and conditions of entry then in existence shall be subject to immediate return to its place of origin at the owner's expense, or, in the alternative, if the owner is unavailable or unable or unwilling to bear the cost of returning the dog or cat to its place of origin, shall be immediately destroyed.

- **Miscellaneous pet importation prohibited** (Rule 24.0318). (a) Miscellaneous pets such as lizards, snakes, turtles, frogs, tropical fish, parrots, cage birds, monkeys, hamsters, rabbits, and similar animals which are regarded as pets are prohibited from being imported into American Samoa; (b) The director of agriculture or his authorized representative will determine whether an animal falls under the miscellaneous pets category if the animal is not enumerated in subsection (a) of this section.

- **Keeping on aircraft and vessels** (Rule 24.0319**)**. It is illegal to maintain any animal or bird aboard any vessel or aircraft in American Samoa for more than 48 hours. Animals or birds must be either destroyed under the supervision of the department of agriculture, shipped off the islands on the first available flight at the owner's expense, or the vessel or aircraft must leave American Samoa after the 48-hour period. During the time the vessel or aircraft is in port, all animals or birds must be kept under strict quarantine aboard the vessel or aircraft. However, if a bond is posted by the owner for the animal and this is approved by the department of agriculture, then the animal may be maintained in the vessel or aircraft. The director of agriculture or his authorized representative will determine the bond on any animal. If the animal is found off of the vessel or aircraft, it may be destroyed by the department of agriculture and the bond forfeited.

- **Domestic animal importation** (Rule 24.0320). All domestic animals, including ruminants (cattle, buffalo, sheep, and goats), horses, mules and asses, swine, and domestic poultry (chickens, ducks, geese, turkeys, pigeons, doves, quail, etc.) may be imported into American Samoa subject to department of agriculture restrictions and health certification.

Plant Rules

- **Compliance with plant, fruit, and vegetable rules required** (Rule 24.0325). No person, firm, or corporation shall import or offer for entry into American Samoa any plants, plant materials, fruits, or vegetables, or plant products except in accordance with the provisions of this chapter, nor shall any of the above be handled or moved after physical entry into American Samoa before final release from quarantine or other form of governmental restriction or detention except in compliance with this chapter.

- **Fruits and vegetables-Fruit fly and citrus disease restrictions** (Rule 24.0326**)**. (a) The importation of fresh fruits, susceptible vegetables, and seeds covered with pulp, is prohibited from areas where the oriental fruit fly (*Dacus dorsalis*) and the Mediterranean fruit fly (*Certitis copitata*) or other injurious fruit fly species are known to occur. Such fruits and vegetables may however, be entered if accompanied by certification of competent authority in the country of origin that it has been subject to an approved treatment at point of origin and subsequently protected from reinfestation until exportation has been effected. (b) The importation of citrus fruits is prohibited from areas where the organism causing citrus canker, cancrosis "B", and sweet orange scab are known to occur,

and shall be permitted entry only when accompanied by a certificate of competent authority in the country of origin stating that it originated in an area free from the aforesaid diseases.

- **Prohibited plants, plant parts, and seeds** (Rule 24.0327). Except as indicated, the following plants, plant parts, and seeds are prohibited entry into American Samoa: (a) All coconut plants or parts thereof, except that nuts may be permitted entry when fumigated with methyl bromide at the port of origin; (b) All rice plants and parts thereof, except milled rice for human consumption; (c) All pineapple and related plants except within the area embraced by the South Pacific Commission; (d) All citrus and related plants or parts thereof for propagation except from areas known to be free from citrus canker or quick decline (Tristezs); (e) All rubber plants and parts thereof from areas where the American leaf disease (*Dothidella ulei*) occurs, and from other areas, only in the four of seed or budwood; (f) All cacao plants and parts thereof from areas where witch's broom (*Marasmium fernicious*) or swollen shoot disease occur; (g) All plants of sugarcane and other species of *Saccharum* or parts thereof; (h) All plants of banana and other Musa species or parts thereof, from areas where panacea disease (*Fusarium oxisporum* var. cubense) or bunchy top virus disease occur; (i) All coffee plants and parts thereof from areas where the coffee bean borer (*Stephenoderes coffee*) exists, or where the blockwood disease of robusta coffee (*Thielaviopsis neocaledonise*) is known to occur.
- **Permit for plant material importation** (Rule 24.0328). Any person, firm, or corporation wishing to offer for entry into American Samoa any plant material shall first obtain a permit from the department of agriculture for their importation. This permit shall detail the amount and kind of plant, point of origin, method of transportation, and type of treatment required, if any, at point of origin. No plants or plant material shall be permitted entry if obtained from other than the indicated point of origin.
- **Certification of plants and materials** (Rule 24.0329). All plants and plant materials offered for entry shall be accompanied by a certificate issued by competent authority of the country of origin, listing the contents of the shipment, their locality and type of treatment, if any, and stating that the plant material covered by certificate was examined and found, to the best of his knowledge, apparently free from injurious pests and diseases. The original of this certificate shall be presented to the inspector of the department of agriculture upon or before the arrival of the shipment at the port of entry.
- **Examination at entry of plants, parts, and products** (Rule 24.0330). All plants, plant parts, or plant products offered for entry into American Samoa shall be subject to examination by an authorized inspector. If such a consignment should be found to be infested with an injurious insect or disease, he may refuse entry to all or a portion of the consignment. Those plants, plant parts, or products refused entry shall be subject to disposal under direction of the director, department of agriculture, by return to the country of origin or confiscation and destruction, or admittance under such treatment and quarantine safeguards as he deems necessary. All costs incident to such disposition, other than the services of the inspector, shall be borne by the importer.
- **Department of agriculture importation** (Rule 24.0331). Nothing in this article shall be construed to prevent the department of agriculture from importing plants, plant materials,

and products from any part of the world for experimental purposes under such quarantine safeguards as the director of the department of agriculture prescribes.

- **Emergency quarantine rules** (Rule 24.0332). The director, department of agriculture, shall have the authority, subject to later confirmation by the Governor, to impose emergency quarantine rules in situations not covered by this chapter and when the situation, in his opinion, so warrants.

Special Rules

- **Refuse disposal by vessels and aircraft** (Rule 24.0335). (a) Vessels and aircraft entering American Samoa from foreign ports are prohibited from dumping garbage, trash, and other refuse into the harbors and protected waters of the islands, and from putting such garbage ashore for disposition, except under the following conditions: (1) The presence of an agricultural quarantine inspector to supervise the loading and unloading of any and all garbage, trash and other refuse containers, fumigation of commodities and certification of commodities to export shall be required. (2) If adequately screened and protected incinerators are available ashore, garbage and trash from vessels entering from foreign ports may be landed for destruction by burning under the supervision of agricultural quarantine inspectors or other appropriate port authorities. Otherwise, garbage and trash shall be accumulated aboard the vessel in covered containers for the duration of the stay of the vessel, and subsequently dumped at sea upon resumption of the voyage. (3) All garbage and trash from land-based aircraft entering American Samoa from a foreign area shall be placed in an insect-proof container while on board the plane, and, under the supervision of agricultural quarantine inspectors or other appropriate port authorities, be taken to an adequately screened and protected incinerator where it shall be destroyed by burning. (4) There shall be a fee of $7.50 (per inspector) per hour assessed against each vessel and aircraft that shall enter American Samoa and do any of the acts mentioned in this regulation.

  (b) Garbage containing animal and plant products: (1) All garbage containing animal and plant products from vessels or aircraft must be held on board the vessel or aircraft while in port. In special circumstances and under the supervision of an agriculture quarantine inspector, the garbage may be placed inside an insect-proof container and unloaded and incinerated or sterilized. The director of agriculture or his authorized representative may determine what are special circumstances. The costs of transporting, incinerating and sterilizing the garbage, which shall be $7.50 (per inspector) per hour, will be charged to the vessel or aircraft. (2) All galley garbage from vessels and aircraft can be considered as containing animal and plant products. This rule shall be strictly enforced on all vessels or aircraft arriving in American Samoa. (3) "Garbage" means all waste material derived in whole or in part from fruits, vegetables, meats, or other plant or animal (including poultry) material, and other refuse of any character whatsoever that has been associated with any such material on board any means of conveyance, and including food scraps, table refuse, galley refuse, food wrappers or packaging materials, and other waste material from stores, food preparation areas, passengers' or crews' quarters, dining rooms, or any other areas on vessels, aircraft, or other means of conveyance.

- **Ratguards on vessels** (Rule 24.0336). All vessels entering American Samoa from foreign ports shall place adequate ratguards on all lines, cables, or hawsers which lead ashore to prevent the entry of rat-borne diseases.
- **Aircraft spraying** (Rule 24.0337). All aircraft entering American Samoa from a foreign area shall, 30 minutes prior to landing, treat all internal passenger and cargo spaces for insects with an aerosol spray formula approved by the U. S. Public Health Service.
- **Packing material prohibited- Exceptions** (Rule 24.0338). All packing materials are prohibited entry into American Samoa except as follows: (a) When such materials have been treated or manufactured so as to exclude the possibility of harboring injurious pests and diseases; (b) When the unopened cases containing packing materials are first subjected to an approved precautionary treatment to kill insects and their eggs. Such cases must be opened in the Customs House, the packing materials removed and destroyed by burning, at which time the consignment may be released from quarantine by the customs officer.
- **Feed and materials-Prohibited when –Certification** (Rule 24.0339). The importation of any straw, fodder, or chaff for animal feeding is prohibited from any area from which ruminants, swine, equines, and poultry are also prohibited entry. Importation of feeds and feed materials from all other areas shall be admitted only when accompanied by certification by competent authority of the country of origin that the area where produced is free from cattle ticks and infectious diseases of livestock.
- **Feed and materials-Approved treatment required when** (Rule 24.0340). All hay, straw, fodder, and other material for animal or poultry feed shall be subject to fumigation or other approved treatment at the expense of the consignee at the port of entry when, in the opinion of the director of agriculture, it is necessary to prevent entry of injurious or undesirable insect pests.

ECOLOGICAL CONTEXT

GEOGRAPHY

All the PACN network parks are located on tropical islands in the Pacific Ocean. Eight of the parks are in the Hawaiian Islands in the Central Pacific between 19 and 22 degrees North latitude. HAVO, KAHO, PUHE, PUHO, and the recently designated ALKA are on the island of Hawaii, the youngest of the main Hawaiian Islands at the southern and eastern end of the archipelago. HAVO is located on the southeast slope of Hawaii Island, where it extends from sea level to the summits of Kilauea and Mauna Loa Volcanoes. The newly designated Kahuku unit of HAVO is positioned on southern Mauna Loa and extends down both the eastern and western flanks of the volcano. PUHE, KAHO, and PUHO are coastal parks of the western side of the island. KAHO is centrally located with PUHE to the north and PUHO to the south. HALE is on Maui, the second youngest Hawaiian Island. HALE extends from sea level to the summit of East Maui. KALA is on a peninsula projecting from the north shore of Molokai, centrally located in the main Hawaiian Islands. USAR is within Pearl Harbor on southern or leeward Oahu. Two PACN parks are situated in the western Pacific Ocean between 13 and 15 degrees north latitude in Micronesia. WAPA is on the western side of the island of Guam and AMME is on the west coast of Saipan, one of the Northern Mariana Islands. NPSA is on the Polynesian islands of American Samoa, approximately 14 degrees south latitude. One unit of NPSA is on the island of Tutuila, and three others are on Tau, Ofu, and Olosega of the Manua Island group 96 km (60 miles) east of Tutuila.

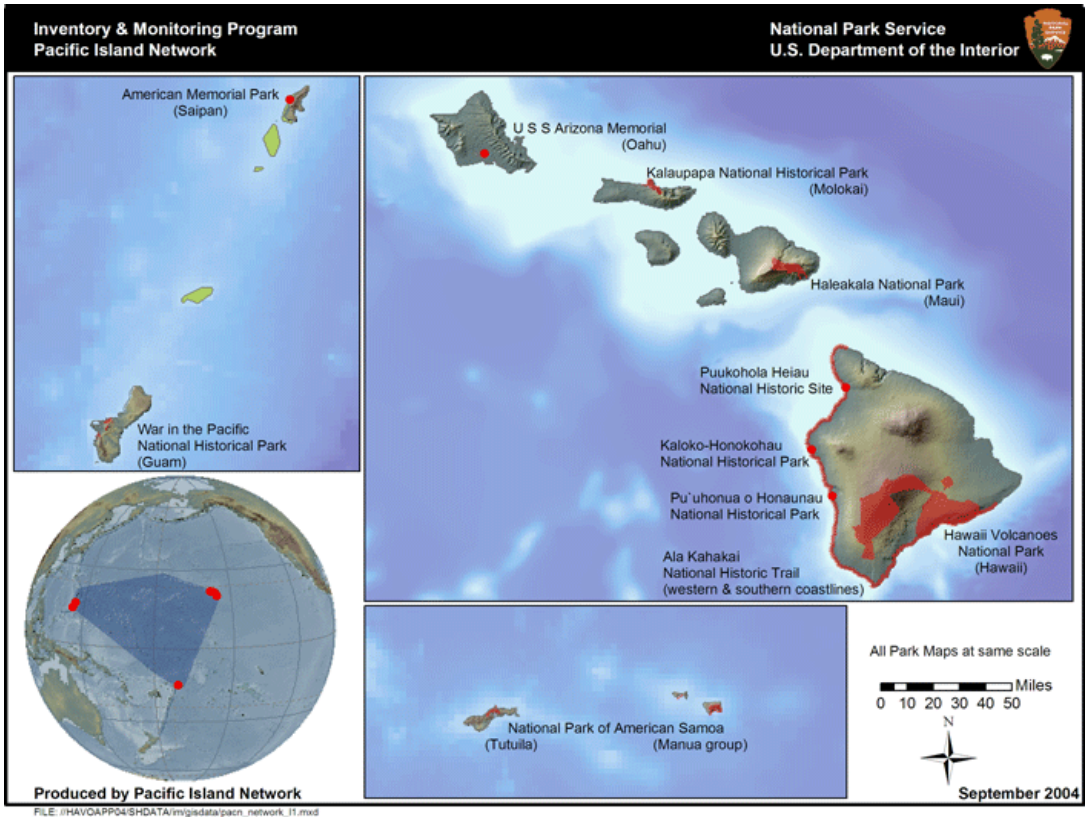

Figure 1. *Pacific Island Inventory and Monitoring Network.*

GEOLOGY

The parks of the Western Pacific (WAPA, AMME) are on the islands of Guam and Saipan which have long-extinct volcanoes. These islands have complicated geologic origins involving both volcanism and subduction of the Marianas Trench. Hence, the northern half of Guam and portions of Saipan have limestone substrates elevated above a weathered volcanic base. WAPA units are on the volcanic substrates of the southern half of Guam, and at least one unit includes elevated limestone caps.

The islands of American Samoa and Hawaii are oceanic volcanic islands arising from hotspots. The oldest of the Samoan Islands are dated at more than two million years, but there was volcanic activity between Tau and Olosega approximately 150 years ago (Whistler 1994). In Hawaii, HALE protects the summit of the inactive Haleakala Volcano and its impressive crater, which is the result of stream erosion, the merging of Kaupo and Keanae Valleys, and subsequent volcanic activity. KALA encompasses the Kalaupapa peninsula, formed on the north shore of Molokai during the Pleistocene (MacDonald and Abbott 1970). The volcanoes on both Molokai and Oahu are extinct.

The five parks on Hawaii Island are on active or dormant volcanoes. A significant portion of HAVO is covered with recent lava flows that are sparsely vegetated. HAVO also contains the rift zones and summit calderas of both Mauna Loa and Kilauea Volcanoes, two of the most active volcanoes on earth. PUHO is on prehistoric pahoehoe flows of Mauna Loa, and PUHE substrates are old weathered soils of Kohala Volcano. All substrates of KAHO are flows from Hualalai Volcano less than 10,000 years old, including one sparsely-vegetated lava flow dated at 1,000-3,000 years (Moore et al.1987).

ELEVATION GRADIENTS

Among the Hawaiian parks, HAVO and HALE have the greatest elevational range, extending from sea level to the summits of tall volcanoes >3,000 m (>10,000 ft) in elevation. KALA has an elevational range from sea level to almost 1,220 m (4,000 ft) elevation. The three parks of leeward Hawaii Island are coastal parks and extend upslope to elevations less than 100 m. ALKA is also in the coastal lowlands of western and southern Hawaii Island.

Among the three Western Pacific parks, AMME is restricted to coastal lowlands on the western shore of Saipan. WAPA includes both coastal units and inland sites on the slopes of Mt. Alifan and Mt. Tenjo, with one unit extending above 305 m (1,000 ft) in elevation. NPSA is composed of four units; Ofu and Olosega are largely coastal, but the Tutuila and Tau units range from sea level to 491 m (1,610 ft) and 966 m (3,170 ft) elevation. The planned expansion of NPSA on Ofu and Olosega will include the summits of both islands, which are 499 m (1,621 ft) and 639 m (2,096 ft), respectively.

RAINFALL AND CLIMATE

The largest two Hawaiian parks, HAVO and HALE, include within their boundaries several climatic zones with a range of rainfall regimes. HAVO contains two of the four rainfall minima of Hawaii Island, the Kau Desert with mean annual rainfall <750 mm and the interior lands of Mauna Loa. The highest mean annual rainfall within the park is found in Olaa Tract, a rain forest with >4,000 mm per year (Giambelluca et al. 1986). In general, the eastern windward portion of HAVO has high rainfall, which diminishes upslope, particularly above the trade wind inversion layer near 1,830 m (6,000 ft) elevation. The upper elevations of the park are moist to

very dry, and the summit of Mauna Loa receives on average <500 mm precipitation. The leeward, western portions of HAVO are in rain shadows of Mauna Loa and Kilauea summit, and are typically dry.

HALE also has a range of climates, as it extends from sea level on the windward, eastern slope of Haleakala to the summit of East Maui. This park also includes lands in the leeward rain shadow of Haleakala, down to 1,220 m (4,000 ft) elevation. Annual precipitation in the park varies from 1,250 mm in the Crater, the southern slope, and Kaupo Gap to >6,000 mm on the upper northeastern slopes of Haleakala. KALA, on the north shore of Molokai receives 1,000 mm of precipitation annually at sea level and >3,000 mm at the upper elevations of Waikolu Valley (Giambelluca et al. 1986). The USAR on Oahu is located within Pearl Harbor on the dry leeward side of the island in an area than has on average 600 mm rainfall per year.

The four Hawaii Island parks are in relatively low rainfall areas with constant warm temperatures and pronounced daily wind patterns of land and sea breezes (Blumenstock and Price 1967). KAHO has a mean annual rainfall of approximately 600 mm and a seasonal climate with higher rainfall during summer months (Canfield 1990a). The climate of PUHO is similar to that of KAHO, with mean annual precipitation of 659 mm. PUHE is located within one of the four rainfall minima of the island of Hawaii and receives <250 mm of rain annually (Giambelluca et al. 1986). Because ALKA covers a large linear coastal transect along West Hawaii, the rainfall pattern is variable.

The climate of Guam and the Northern Marianas (CNMI), including Saipan, is warm, wet, and tropical. Temperature varies between 90 and 70o F. Relative humidity is high, often exceeding 80% and seldom falling below 50%. The rainfall pattern is strongly seasonal with a wet season from July to November and a pronounced dry season from December to June. Average annual rainfall of the Marianas is 2,160 mm (85 in) (Baker 1951), and on Guam the annual mean is 2,175 mm (Mueller-Dombois and Fosberg 1998). Typhoons are yearly events, which occur during the monsoonal wet season. Trade winds blow from the northeast, but easterly and southeasterly winds prevail during several months in the spring (Baker 1951). Because Guam and the Marianas are relatively low islands, there is no pronounced rain shadow effect, and leeward shores are not drier than those of the windward sides (Mueller-Dombois and Fosberg 1998).

NPSA has a warm tropical climate with little seasonal variation in temperature. Rainfall is high in the four units of the park. On Tutuila, annual rainfall averages 3,200 mm (124 inches at the airport, and may be even higher on the upper mountain slopes within the park. Rainfall is seasonal with greater monthly means from October to May and a dry season from June to September. Hurricanes are occasional but not annual events (Whistler 1994). Tau Island unit is only about 96 km (60 miles) east of Tutuila and shares its warm and wet tropical climate. Tau average rainfall is more than 2,500 mm per year and is highest in December. The dry season is June to September, and droughts sometimes occur on the island (Whistler 1992).

CONCEPTUAL ECOLOGICAL MODEL

The delegates of the 2002 Austral-Pacific Regional Workshop on Invasive Alien Species, stated that invasive alien species (IAS) are the leading cause of extinctions in the Pacific and affect the entire Pacific region (Shine et al. 2003). They emphasized that marine IAS are probably as great a problem as terrestrial IAS. Delegates of this workshop, which was hosted by the Bishop Museum and coordinated by the Global Invasive Species Program (GISP), included among others representatives from all states or territories included in the PACN. Furthermore, the vegetation/flora working group of the PACN determined that invasive species presently comprise the most significant stressors for many if not most ecosystems of PACN national parks. A general conceptual model (Figure1) by Dukes and Moody (2004) shows the large-scale interactions involving alien species.

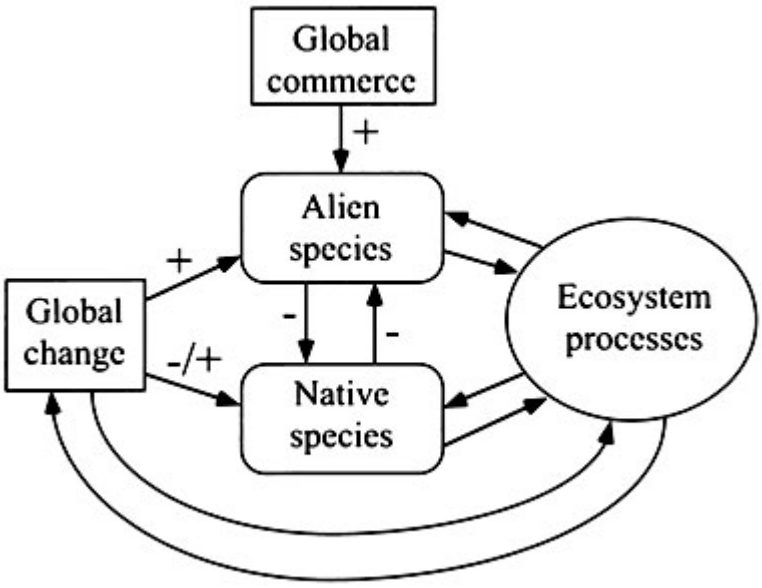

Figure 2. *A general conceptual model outlining the interactions between alien and native species, ecosystem processes, global change and global commerce as presented in Dukes and Mooney (2004). Arrows show directions of influence, symbols indicate whether a given influence is generally thought to be positive or negative. Because "ecosystem processes" encompasses several independent elements that are not easily generalized, arrows from and to this compartment do not have symbols.*

As illustrated by the 'global commerce' box in the model, one of the major drivers for alien species invasions is the breakdown of biogeographic barriers through intentional or unintentional transport of biological organisms by humans. Such transport of organisms by humans does not appear to be slowing down. To the contrary, the process of globalization is in many ways growing due to ever-increasing trade, transport and travel. Therefore, species invasion will only be slowed in the immediate future by measures purposely implemented to prevent, detect, rapidly respond to, and manage invasions. Early detection of invasive species thus focuses on monitoring presence/absence, distribution and abundance of: 1) new and incipient invasive species of high risk to Hawaii and Pacific Islands; and 2) selected highly problematic species currently established outside (but not yet inside) the parks.

PARK AND NETWORK-WIDE ISSUES

Adequately conveying the severity of the current invasive species crisis as it affects PACN parks, endemic biodiversity, and local cultures is a daunting task, but the following summary of recently introduced or threatening pests that are especially damaging illustrate the dire straights that Pacific islands are in. Sadly, there seems to be little hope of changing the status quo without drastic activism by the NPS and partners, since it seems likely that most of these pests came to Hawaii and Pacific Islands from foreign countries and would not have been considered actionable quarantine pests if intercepted by DHS/USDA at international ports, because none of them would be considered threats to mainstream U.S. agriculture. This may well be a rational national response to the challenging demands of protecting U.S. agriculture from foreign pests in this age of free trade. However, it seems important to at least consider the cumulative toll being taken on the natural and cultural heritage of Hawaii and Pacific islands, as manifested in national parks and elsewhere. Examples of recent invaders in the PACN region include (Table 3):

Erythrina gall wasp (*Quadrastichus erythrinae*): This species was first reported on Oahu in April 2005. It was originally probably from Africa but most likely passed to Hawaii from Taiwan (where the species is invasive and recent outbreaks occurred) in flowers or nursery material. Suddenly, this very tiny wasp (males are 1mm long, females 1.5mm) is currently in the process of killing almost all Erythrina on Oahu, both the endemic species (wiliwili) and the cultivated species. There are recent reports of new neighbor island records of the gall wasp near the Kona (Hawaii island) airport (7/21/05), the Kauai airport (7/26/05) and downtown Kahului, Maui (7/30/05). Sadly, the prospects for Maui's Puu-o-Kali wiliwili preserve and the wiliwili in the proposed Nuu addition to Haleakala NP and all the national parks on Hawaii island are absolutely frightening. As little as three years ago, the magnificent native wiliwili trees on Maui seemed to be "bulletproof." Three years ago a seed-eating bruchid beetle (*Specularius impressithorax*) from Africa suddenly arrived and was soon attacking almost all wiliwili seeds. Today, as a result of arrival of the Erythrina gall wasp, the possibility of survival of wiliwili, until now one of the few abundant endemic tree species in remnant areas of lowland dry areas of Hawaii, through the coming year is even in doubt. This is especially unfortunate because of the traditional importance of wiliwili for native Hawaiians in making outriggers of canoes, surfboards, and lei. The HEAR-website provides updates on this rapidly evolving issue.

Ohia rust disease (*Puccinia psidii*): Another plant trade-related introduction, this newly established (April 2005) rust, is believed to have most likely arrived with a plant shipment from Brazil or a nearby country, poses a potentially formidable threat to Hawaii's ohia (*Metrosideros polymorpha*) forests. This is of course alarming since ohia comprises over 80% of Hawaii's still-intact forest. The rust seems to have a broad host range within its family (Myrtaceae, including mountain apple, guavas, eucalyptus, etc.). This rust disease that attacks new, actively growing leaves is not just a threat to Hawaii's forests. New Zealand will be looking out to protect its beloved *Metrosideros* forests. Australia is definitely concerned for its 600+ endemic species of Eucalyptus. ohia rust was at first detected only in forests on Oahu, though Maui HDOA found ohia rust disease in shipments from Oahu to at least two big box stores on Maui during July 2005. On August 18, 2005, ohia rust was first found on Maui.

Nettle caterpillar (*Darna pallivitta*): Another invader from Taiwan, this is a human health threat (various levels of discomfort ranging to occasional anaphylactic shock and blindness) as well as a serious environmental pest, attacking palms and related plants. Dr. Arnold Hara of UH-CTAHR in Hilo has stated (quoted in the Honolulu Star-Bulletin) that it is a worse pest than the

notorious coqui frogs. The vector via which it arrived is obviously nursery material, and it is likely spread daily on Hawaii island (along with coqui, etc.) by infested nurseries. In spite of HDOA efforts at inter-island quarantine, Maui HDOA has documented it at least once in a shipment from the Big Island to a Maui nursery. Unless some biocontrol agent is located and processed rapidly through the extremely restrictive system, this pest will soon be in rain forests of Hawaii Volcanoes National Park.

Little fire ant (*Wasmannia auropunctata*): This tiny neotropical ant has devastating effects on biodiversity and human quality-of-life in its invaded range in far-flung parts of the world (e.g., Galapagos, New Caledonia, West Africa). It was first detected in Puna, Hawaii, in 1999, and HDOA is now reporting it from 50 sites on Hawaii Island. Its localized spread after its initial discovery has been associated with transport of nursery plants. There is an HDOA interisland quarantine for little fire ant, and to date it remains confined to Hawaii Island, except for a small population on Kauai that is under control but not eradicated. The poorly understood effects of this species in blinding mammals, perhaps by stinging their corneas (Walsh et al. 2004), are just now starting to appear in housecats in the Puna area of Hawaii island.

Scale insect of hala (*Thysanococcus pandani*): Hala (*Pandanus tectorius*) is common to abundant in many Hawaiian coastal ecosystems and an extremely important plant species for native Hawaiians, who have traditionally used it for cordage, thatching, healing, decoration, etc. The scale insect arrived on the island of Maui in 1995, apparently on a shipment of hala brought in to a botanical garden from somewhere in the western/southern Pacific. Hala is currently sickly with yellowing leaves over much of windward East Maui, though the insect's effects have not yet reached the Kipahulu section of Haleakala National Park. Hala is an important component of the national parks in the Kona area of Hawaii island. Long-term effects of scale attack on hala populations are likely to be severe, but that is uncertain at this point in time. The South Pacific island of Rarotonga, in the Cook Islands, apparently lost its Pandanus in the 1920s from a similar accidental insect introduction.

Cycad scale or sago palm scale (*Aulacaspis yamatsui*): Guam has more than one million trees of the Micronesian endemic cycad (*Cycas micronesica*), a magnificent tree that reaches heights of 80-100 ft, and all currently seem to be at risk from attack by this scale insect. Cycad scale reached Florida, transported on cycads from native Thailand in 1996, reached Hawaii (which has no native cycads) on cultivated cycads from Florida in 1999, and reached Guam from Hawaii in 2003. There are approximately 30 nurseries in Guam that bring in nursery stock from Hawaii. Guam is tightening up its regulations for horticultural imports because of recent pest incursions, including cycad scale and coqui frogs.

Red Imported Fire Ant (RIFA, *Solenopsis invicta*): This is a species not in Hawaii or any Pacific island yet but is poised to invade from either side of the Pacific Rim – from California (where Hawaii gets most of its goods and where RIFA was first discovered in 1998) and China/Taiwan/Hong Kong (where RIFA first got a foothold in 2004-05). It seems clear that RIFA can invade Hawaii and Pacific islands, with devastating consequences, based on various models of potential habitat, as well as by the fact that it has invaded many Caribbean islands over the past two decades.

Tropical Aquarium Seaweed (*Caulerpa taxifolia*): This green seaweed is not yet found in the waters of the Pacific Island Network, though it poses a significant threat to Hawaii, Guam, and American Samoa. It grows over coral and rocky reefs, from shallow waters to depths of 90

meters. In the 1980's, this tropical seaweed became established in the Mediterranean Sea and it now covers over 4000 hectares. The importation and sale of this seaweed was banned in the United States in 1999, though it has shown up in two lagoons in California since then.

Table 3: Examples of invasive species.

Invasive Species	PACN parks which could be or are effected by these species
Erythrina gall wasp (*Quadrastichus erythrinae*):	All Hawaii Parks
ohia rust disease (*Puccinia psidii*):	All Hawaii Parks
Nettle caterpillar (*Darna pallivitta*):	HAVO
Little fire ant (*Wasmannia auropunctata*)	HAVO
Scale insect of hala (*Thysanococcus pandani*):	HALE
Cycad scale or sago palm scale (*Aulacaspis yamatsui*):	WAPA
Red Imported Fire Ant (RIFA, *Solenopsis invicta*):	All Hawaii Parks
Tropical Aquarium Seaweed (*Caulerpa taxifolia*):	All Hawaii Parks, WAPA, NPSA

MONITORING

This section lists long-term monitoring programs for the detection of incipient invasive species within the U.S. Pacific Region. In addition to listing programs in Hawaii, Guam, Saipan and American Samoa, which host PACN national parks, this section also lists monitoring programs for New Zealand. The New Zealand islands suffer many of the same problems stemming from invasive species as the PACN, and the country has developed advanced monitoring programs that can serve as an example for other regions.

REGIONAL PROGRAMS

Pacific Fruit Fly Surveillance Program

This is the surveillance component of the Secretariat of the Pacific Community (SPC) Plant Protection Service Project on Pest Management in the Pacific, Component 2 – Fruit Fly Management. This program was initiated in 1990 as the Regional Fruit Fly project, a three phase project to increase production and quality of produce in the Pacific, and facilitate trade. The program was moved into the SPC Project on Pest Management in 2001.

The Pacific fruit fly surveillance program includes 1) a network of permanent fruit fly trapping sites throughout the region, and 2) host fruit surveys in some Pacific Island Countries/Territories (PICTs). Updated results of surveillance activities (by both PICT and fruit fly species) are provided on the program's website, www.pacifly.org.

As of December 2004, the trapping network included a total of 892 sites with Cue-lure traps, 1197 sites with methyl eugenol traps and 27 sites with Trimedlure traps located throughout the 22 SPC member PICTs. PICT participation involves checking and maintaining traps, and reporting results to the SPC managed program. Guam, CNMI, and American Samoa all have permanent trapping sites that are part of this network (for details, see the individual Programs section of this report for these regions).

Host fruit surveys involve collecting fruits in various locations and incubating the samples in the laboratory for two to three weeks to determine whether they are infested with fruit flies. These surveys provide information on the host range of different fruit fly species, economic importance of species on different hosts, host stage of maturity when infestation occurs, comparative level of fruit fly susceptibility of different host species and varieties, and diversity and impact of natural parasitoids. They also help to sample fly species not attracted to lures (www.pacifly.org). For details of PACN territory host fruit survey activities.

FEDERAL PROGRAMS

U.S. Customs/Department of Homeland Security (DHS) port-of-entry inspections for foreign arrivals

At ports-of-entry, U.S. Customs/DHS inspect goods arriving from foreign countries to detect illegal articles (including plants and animals), ensure that regulated articles comply with federal regulations, and intercept regulated pests. In Hawaii, a small percentage of incoming air passenger baggage, air cargo, maritime cargo, and mail from foreign countries are inspected at Hawaii's international ports. Items are chosen for inspection based on risks as determined by risk assessments, past interceptions, and other available information. Articles are inspected for pests and disease and may be released, subject to quarantine treatment prior to release, or confiscated (Wasem et al. 2004). The program's primary aim is to intercept agricultural pests and diseases.

The federal regulations pertaining to foreign imports are complex, as, subsequently, are the rules and guidelines for inspection of incoming goods. Rules, guidelines and protocols for inspection are found interspersed in a number of USDA-APHIS-PPQ manuals, including the Airport and Maritime Operations Manual, Animal Product Manual, Plant Import – Nonpropagative Volume of Manuals, and Port of Entry Manual. Only "reportable interceptions", as defined in the Airport and Maritime Operations Manual's Appendix T are entered into the USDA-APHIS pest interception database, (i.e., the Port Information Network 309 database). Unfortunately, access and use of the data collected from this program are restricted to authorized employees of USDA-APHIS and cooperating agencies.

Guam is outside the U.S. Customs Zone and therefore inspections of incoming goods and persons are not conducted by U.S. Customs or DHS. However, the local customs authority, the Guam Customs and Quarantine Agency (CQA), enforces United States Department of Agriculture (USDA) and territorial Department of Agriculture regulations pertaining to the importation of plant and plant products into Guam. This involves inspection of incoming goods, including all live plants, and referral of pests or suspect items to the APHIS Plant Inspection Station, which is run by Guam Department of Agriculture (Paul Bassler, pers. comm., November 10 2004). APHIS import regulations also apply in CNMI (Carol Russell, pers comm. March 31 2004), which has its own Customs, Immigration and Quarantine agency. American Samoa is self-governing, and regulates imports without USDA/DHS involvement. The extent of USDA involvement in plant protection and quarantine activities is limited to training by USDA personnel (Carol Russell pers. comm. March 31 2004).

USDA-APHIS Agricultural Quarantine Inspection Monitoring (AQIM)

The purpose of the AQIM program is to gather data regarding agricultural quarantine inspection effectiveness. The data are used to better define and document the pest risk of various pathways,

help determine how likely it is for agricultural pests and diseases to enter the U.S. through various identified routes, and communicate to DHS those agricultural risks that need DHS inspection attention.

At each selected airport (including Honolulu International Airport), border crossing, and mail facility, DHS officers conduct 3,650 total random inspections each year of passenger baggage, vehicles, and mail. At cargo facilities, various types of cargo shipments are randomly selected each year for complete inspection. Results of vehicle and passenger baggage inspections are used to estimate the rate of quarantine material arriving at each port. This estimate is used as the basis for program effectiveness and efficiency indicators. For cargo, results are used to estimate rate of cargo shipments requiring action as they arrive at a port, and percentage of units approaching with significant pests. These can be used by ports to estimate their effectiveness in managing the pest risk in cargo, and to evaluate the relative risk of various known pest entry pathways.

Sampling and data collection protocols are described in the USDA-APHIS AQIM Manual . Unfortunately, access and use of the data collected from this program are restricted to authorized employees of USDA-APHIS and cooperating agencies.

HAWAII PROGRAMS

Hawaii Department of Agriculture (HDOA) Plant Quarantine Division port-of-entry inspections of foreign arrivals

After clearance by Customs and DHS, HDOA conducts inspections on a percentage of goods for State-regulated articles. The percentage inspected is based on risk, as determined by risk assessments and past interceptions. For regulations pertaining to specific seeds, plants, pests, and non-domestic animals, see Hawaii Administrative Rules (HAR)Title 4 (chapters 67 to 71). (Neil Reimer, pers.comm. February 17 2004).

- **HDOA Plant Quarantine Division port-of-entry inspections of domestic arrivals**. HDOA inspects a percentage of all agricultural items, including plants, plant parts, non-domestic animals, microorganism cultures, arthropods, and soil coming in from the mainland U.S.. Items/shipments are selected for inspection based on risks as determined by risk assessments and past interceptions. Data from all interceptions are recorded into a database. Access of this database is restricted to authorized HDOA personnel, though requests for specific data summaries can be made to HDOA. (Neil Reimer pers. comm. February 17 2004). Since 1989 HDOA methods have included the use of dogs to assist PQ inspectors in detecting and intercepting prohibited and restricted items in passenger baggage and express parcels. The dogs are trained to sniff out plants, cut flowers, fresh produce, soil, salt and fresh water (for the presence of live fish and seafood), as well as other live animals such as snakes. (Neil Reimer pers. comm. February 17 2004).
- **HDOA Plant Quarantine Division inspection of goods shipped intrastate**. As per Chapter 72 of the State Rules, all plants and propagative plant parts, and non-domestic animals, including mammals, birds, fish, reptiles, amphibians and insects require inspection and certification prior to shipping from Oahu to outer islands. No inspection is required for seeds, cut greens (including christmas trees), flowers, and leis; or for pigeons, domestic rabbits, poultry, horses, cattle, cats and dogs.
- **HDOA Agricultural Quarantine Inspection Monitoring (AQIM)** In addition to USDA, HDOA has also implemented an AQIM program, whereby statistical/random

sampling techniques are used to survey pest occurrence in maritime containerized cargo from the mainland U.S.. Sampling and data collection protocols are as described in the USDA-APHIS AQIM manual. Access to the data from HDOA's AQIM program is restricted to authorized HDOA personnel. (Neil Reimer, pers comm. February 17 2004).

- **HDOA Division of Animal Industry inspection of imported animals**. As per Hawaii Administrative Rules Title 3 and 4 (chapters 16-29) all animals are subject to inspection by a state veterinarian or inspector for signs of transmissible disease and external parasites on entry into the state.

  Domestic animal disease surveillance State requirements for reporting of animal diseases and disease agents. HAR Title 4, Ch.22 requires that veterinarians within the State report all cases of reportable diseases or disease agents suspected, observed or diagnosed, to the state veterinarian. Reportable diseases include those on the Office of International Epizootics Lists A and B and supplementary Hawaii disease list I (HAR Title 4 Ch.22, Exibit A). Written or verbal notification of list A diseases/disease agents must be made immediately or within 24hrs. Notification of list B and list I diseases/disease agents must be made within the time period stated in HAR 4-3-22 Exhibit A. Notification must include at least: 1) the name of the reporting veterinarian, 2) the disease/disease agent being reported, 3) species, location, and number, of animals involved, and 4) name and address of the animals owner.

  In addition to HAR 4-22, Hawaii State Rules regulating import of swine and poultry/birds also contain disease-reporting requirements. Post-entry regulations require swine owners (or their agents) to report, without delay, any sign of hog cholera or African swine fever to a state or federal veterinarian. Post-entry regulations for poultry/birds require that birds are held in isolation for 30days at the importers premises and that all instances of sick or dead birds occurring during this period be reported promptly to HDOA, and be made available for testing if requested. Poultry/birds imported directly into the state from a USDA-approved quarantine facility are exempted from isolation requirements.

- **HDOA inspection of Guam aircraft/ships for Brown Tree Snake (BTS)**. Since 1992 HDOA has conducted inspections for detection of BTS in aircraft and ships arriving into Hawaii from Guam. HDOA attempts to meet and inspect (for BTS) all flights from Guam, and usually end up inspecting 97-98% of arriving flights. HDOA also inspects all military aircraft and ships arriving from Guam. Tree snake inspection is conducted via visual inspection and sometimes via the Brown Tree Snake Canine Unit. Aircraft wheel wells are inspected with dogs. For military flights, HDOA inspectors do a walk through of the cargo hold without dogs, and use dogs to check cargo when it is off loaded. Commercial flights are handled similarly, with cargo checked by dogs when it is offloaded. During the 6 month period prior to April 25 2004, HDOA inspected 267 commercial flights, 323 military flights, and 7 private flights for BTS. HDOA supplements their BTS inspections with BTS public education in Hawaii schools (Neil Reimer pers comm. April 25 2004).

Surveillance for livestock diseases through State, and federal-State cooperative programs

Several testing-based surveillance programs exist in Hawaii for detection of livestock disease. These are conducted through both state programs and federal-state cooperative programs. Diseases for which testing is conducted include the following:

- **Anaplasmosis**. Cattle are blood tested for anaplasmosis upon entry into the state, and are retested within 60-90 days. In addition, in accordance with HAR, blood samples are collected at slaughter from all cattle three years of age and older and forwarded to the veterinary laboratory for anaplasmosis testing.
- **Brucellosis**. Cattle are blood tested for brucellosis upon entry into the state. In addition, in accordance with HAR, blood samples are collected at slaughter from all cattle three years of age and older and forwarded to the HDOA veterinary laboratory for brucellosis testing. Samples of milk produced in licensed dairies are also collected and forwarded to the veterinary laboratory for brucellosis testing as often as deemed necessary by the state or federal veterinarian to maintain surveillance of brucella infection within the herd.
- **Brucellosis (swine)**. In accordance with HAR, blood samples are collected at slaughter from all female swine six months of age and older and forwarded to the HDOA veterinary laboratory for brucellosis testing.
- **Bovine Tuberculosis**. All cattle are blood tested for tuberculosis upon entry into the State. In addition, tissue samples are collected from cattle, bison, goats, and captive cervids at slaughter plants, as part of federal and state meat inspection programs.

  Surveillance in wildlife (i.e., feral pigs and goats, axis deer, and mongoose) has been conducted on Molokai since 1998. The objective is to establish a control or eradication plan for bovine TB in wildlife on Molokai by 2007 (HDOA 2003).
- **Pseudorabies**. Imported swine are tested 30 days after arrival.
- **Equine Infectious Anemia (EIA)**. Horses, mules, asses are retested for EIA 45-60days after entry.
- **Johne's disease**. Surveillance is conducted via volunteer herds, in accordance with the USDA Uniform Program Standards for the Voluntary Bovine Johne's Disease Control Program (http://www.aphis.usda.gov/
- **Bluetongue**. Surveillance for Bluetongue is conducted via USDA's National Veterinary Services Laboratories for BT testing. Blood samples collected for brucellosis testing from slaughter cattle are submitted to the National Veterinary Services Laboratory for testing. All samples are tested by the BT CELISA test using a commercially available diagnostic kit according to manufacturer's directions.
- **Transmissible Spongiform Encephalopathy** (Scrapie, Bovine Spongiform Encephalapathy, Chronic Wasting disease) Some samples are sent for Bovine SE testing. The State plans to increase the surveillance program and laws to be consistent with national TSE programs (HDOA 2003).
- **Pullorum-Typhoid disease**. Ducks, geese, pigeons, and Galliforme species that don't originate from a flock having a Pullorum-Typhoid clean rating in a state or national plan, must be tested for Pullorum-Typhoid disease within 30 days of entry.
- **Newcastle's disease**. Non-commercial chickens are required to be test-negative for Newcastle's disease virus by the hemagglutination inhibition assay within 14 days of entry.

Hawaii Department of Agriculture (HDOA) - other survey efforts

- **HDOA surveys of certified nurseries for burrowing nematode, reniform nematode and little fire ant**. HDOA allows "BN-certified" nurseries to ship plants from their certified benches without inspection at the time of shipment. Conditions of certification are that the bench in question is free of burrowing nematode, reniform nematode and little fire ant (LFA). HDOA inspectors conduct biannual inspections at participating nurseries for presence of these pests. Only benches within a nursery that the owner/manager wants certified are surveyed, and plants from areas of the nursery other than certified benches are subject to the same shipping requirements as non-certified nurseries. (Pat Conant, pers.comm., February 11 2004; Neil Reimer, pers.comm. 2004).

  LFA surveys consist of placing chopsticks, dipped in peanut butter, at 10-15ft intervals under the certified benches. All ants found on chopsticks are identified, which serves to detect other ant species (that are attracted to peanut butter bait) as well. (Pat Conant, pers.comm., February 11 2004; Neil Reimer, pers.comm. 1999&2004)

  HDOA monitoring of Big Island plant exports for little fire ant (LFA). In November 1999 HDOA implemented a 100% inspection policy for all plant material exported from the Big Island, except those from certified benches of BN-certified nurseries. Shipments of 10 or fewer plants are visually inspected, with potted plants depotted to determine if LFA is present. For shipments of more than 10 plants, peanut butter bait sticks are placed in random pots and checked for the presence of ants after one hour. A log of the name, address, mailing address, and phone number is kept of all non-certified growers that ship plants from the island. When LFA are detected in a shipment of plants from an uncertified nursery, the log allows HDOA to track the location of the LFA infestation from where the plants originated. (Pat Conant, pers.comm. February 11 2004; Neil Reimer. pers.comm. 2004; Reimer 1999 [memo]).

- **HDOA Red imported fire ant (RIFA)** surveys at high risk sites. Federally funded RIFA surveys were initiated by HDOA in 2002 (Carol Russell pers. comm. February 6, 2004). Although initiated fairly recently, these efforts have the potential to become the starting point for long-term monitoring for detection of RIFA, LFA and other new/incipient ant species in Hawaii.

  Currently the efforts for detection of RIFA include biannual surveys at a number of high-risk sites including some airports and harbors (HDOA unpublished data). Methodology includes placing spam in open vials at 50ft intervals in areas where ants may be present (e.g., where soil is present) as determined by the inspector. After approximately an hour, vials are capped. All ants collected in the vials are identified, which serves to detect other ant species (that are attracted to spam) as well. (Pat Conant, pers. comm. 2004).

  The HDOA monitoring effort for presence/absence of RIFA could be strengthened by conducting surveys at all ports, and inclusion of annual surveys at uncertified nurseries (and uncertified benches/areas of certified nurseries), annual surveys at additional high-risk sites, and facilitation of passive surveillance through increased outreach/education.

- **HDOA passive surveillance for Africanized honeybee** (AHB). *Apis mellifera* scutellata. Suspect wild populations reported by the public are trapped and sampled by HDOA for AHB (HDOA 2004).

- **HDOA surveys for honeybee pests**. HDOA conducts biannual apiary surveys for detection of four honeybee pests, the small hive beetle (*Aethina tumida*), varroa mite (*Varroa destructor*), tracheal mite (*Acarapis woodi*), and mite Tropilaelaps clareae. Surveys are conducted biannually. Methodology consists of inspecting four apiaries per commercial or hobbyist beekeeper. Bees are collected from three hives within each apiary. A total of 500 adult bees are collected from each commercial or hobbyist beekeeping operation, i.e. roughly 40 bees per hive and 125 bees per inspected apiary are collected for inspection for presence of pests. (Pat Conant, pers.comm. 2004).
- **HDOA Papaya mealybug surveys**. HDOA initiated detection surveys in late 2003 for papaya mealy bug, which was not known to occur in Hawaii. It occurs in Mexico, Central America, Florida and Guam, and has a wide host range (e.g., plumeria, hibiscus, eggplant, avocado, citrus). Surveys were initiated on Oahu and Maui. (HDOA 2004). Update (8/05): Specimens of papaya mealybug were first found in central Maui in early May 2004 and identified a month later. HDOA is investigating several parasitoids for biocontrol (Heu and Fukada 2004) that have worked well in Puerto Rico and Guam, resulting in a 99% reduction of papaya mealybug in first year. Meanwhile papaya mealybug attacks numerous native plants on Maui, including *Hibiscus brackenridgei*, Hawaii's state flower.
- **Ohia rust surveys**. Following discovery of a rust disease on ohia on Oahu in April 2005, later tentatively identified as *Puccinia psidii* and referred to locally as ohia rust, HDOA has ongoing surveys to determine the distribution of the rust, and HDOA-PQ was in the process of developing interim rules to prevent the movement of plant and plant parts in the family Myrtaceae. The conventional wisdom, however, has been that it is just a matter of time before it is on all islands; it was found on Maui in August 2004.

Surveillance by other agencies and institutions

- **West Nile Virus (WNV) surveillance**. WNV surveillance includes efforts by UH, DOH, DOA, DOD-Army, and USGS. Hawaii's WNV Surveillance Workgroup documents the efforts: (1) UH has been conducting RT-PCR on internal organs of dead birds that are submitted to the humane society of HI on Oahu through a program administered by DOH. Five to10 birds per month are submitted There is a need for faster testing method and more rapid arrival of samples post collection. UH is also testing mosquitoes by PCR for vector control. Mosquitoes are speciated (75% are *Culex*). This is not done regularly; 300 pools have been tested over less than 1 year. (2) The HDOH-Vector Control Group does weekly mosquito collections using New Jersey light traps near major ports of entry (harbors and airports) within a 5 mile radius. Mosquitoes are identified to species. (3) Through the UH Cooperative Parks Studies Unit Mosquito distribution is being mapped by a graduate student. Seven years of mosquito collection data are incorporated into a predictive spatial GIS model. (4) DOD-Army does mosquito surveillance on military lands on Oahu and at Pohakuloa training area. Four unspecified geographic zones are surveyed 1/week (mainly areas inhabited by humans) comprising 2 million acres. Two methods are used; dry ice/CO_2 baiting (not recommended) and CDC light trapping. They catch ~200 *Culex* per night. Army veterinarians are potentially available to do bird necropsy and organ removal from birds (not WNV testing) but submissions are low. HDOH is looking at encephalitis cases in humans, testing for IgM, IgG. Specimens are sporadic and come mainly from cases of fever of unknown origin. (5) HDOH has ordered a strain of West Nile for PRNT. HDOH can also do RT-PCR for WNV. HDOA staff

calls equine vets once a week for WNV cases. If vets vaccinate, an IgM ELISA must be used to detect infection versus exposure. (5) USGS conducts airport surveillance. Fifty birds are collected from various airports including Dillingham, Barbers Point and Hickam each week and bled. Seventy five birds are tested each month by Orange County Vector Control District, and the remainder are banked. Blood is screened for flavivirus by hemaglutination inhibition and positive samples tested for WNV and SLE by ELISA. Positive ELISA tests are confirmed by serum neutralization. Java finches and lace neck doves are primarily targeted for bleeding. About 3000 birds have been bled to date, with about 40 % of blood samples tested. All results were negative. USGS also investigates unusual bird mortalities. Serological data from native forest birds are potentially available from avian malaria studies on the Island of Hawaii. (WNV Surveillance Workgroup meeting notes Appendix 2; Jeff Burgett pers.comm. 2004).

- **Opportunistic surveillance of wildlife disease**. Necropsies and diagnoses are conducted opportunistically on dead wildlife submitted by various agencies and/or the general public to determine cause of death. Data collection on causes of mortality is conducted by USGS – National Wildlife Health Center, HDOA, HDLNR-DOFAW, National Marine Fisheries Service, and Hawaii Volcanoes National Park. HDLNR-DOFAW collects data on native birds. HDOA has collected data for over 20 years on birds, freshwater fish, amphibians/reptiles, mongoose and other rodents and ungulates. NMFS has collected data on sea turtles and marine mammals since 1984, and HAVO has collected data on nene and dark-rumped petrel since 1966. (Thierry Work, pers. comm. 2004).

- **Hawaii Coral Reef Initiative Coral Reef Assessment and Monitoring Program (CRAMP) and West Hawaii Aquarium Project (WHAP)**. CRAMP was developed during 1997-1998; actual monitoring began in 2000. CRAMP is an integrated Statewide, UH and Hawaii Department of Aquatic Resources coral reef research program, common database, and rapid information dissemination system. The purpose is to provide the means for managers and researcher to detect and respond to environmental threats to Hawaii's reefs by detecting change in benthic and fish communities. Experimental design allows detection of changes that can be attributed to a variety of factors pertinent to detection of new/incipient species, including introduced species, algal invasions, and fish and invertebrate diseases. CRAMP uses statistically valid survey techniques for detecting change in benthic and fish communities at over 30 monitoring sites in the state.

  In order to meet the legislative mandates associated with CRAMP, it was necessary to focus all resources of the program on the Big Island during the first year of CRAMP. During the second year the Big Island project was established as a separate program, (i.e., the West Hawaii Aquarium Project WHAP). The West Hawaii sites listed as priority sites by HDAR in 1998 became the nucleus of WHAP. Additional CRAMP sites on the Island of Hawaii were added to provide a full cross section of Hawaiian coastal environments. The WHAP program monitors fish species composition, and uses the standard methods developed by CRAMP to estimate coral abundance, diversity and distribution (Jokiel et al., 2001).

- **Pelekunu Stream Aquatic Insect Monitoring**. Aquatic insect surveys of Pelekunu Stream on Molokai are a continuing biological monitoring program initiated by Bishop Museum personnel in 1991. So far, surveys have been conducted during 1991, 2000, 2001, and 2002. Collections of aquatic insects in the Pelekunu watershed are made in

elevations ranging from sea level to approximately 800 ft in the Pilipililau tributary. Collected insects are identified to species, and their geographic status (endemic, indigenous, or introduced) determined. (Englund and Arakaki 2003).

- **Hawaii Biological Survey (HBS) Database**. HBS Records synthesize the piecemeal and coordinated work of others to provide a yearly update of all records of new/incipient species in the State. It is essentially a clearinghouse of new/incipient records in Hawaii. (Neal Evenhuis, pers.comm. 2003).
- **Passive surveillance of invasive pests in Hawaii**. HDOA, DLNR-DOFAW and the Invasive Species Committes (ISCs) on the islands all conduct some degree of public education/outreach about invasive species and take calls from the public about suspect organisms. However, there is limited effort to enlist the public's assistance in broad, or state wide, early detection efforts for new, high risk organisms. Outreach and education efforts are usually aimed at alerting the public to the existence of newly detected pests and how to report them, in an effort to assist ISCs and State agencies in locating new individuals or populations for control and eradication (HDLNR 2002; HDOA 1999). HDOA maintains a Pest hotline for Oahu.
- **USGS Road surveys for incipient weeds on Maui**. USGS-BRD, Haleakala Field Station, has worked with the Maui Invasive Species Committee since its inception and has surveyed the island of Maui for roughly 100 plant species perceived as potential incipient invaders. Maps, images, and reports are available through the Hawaii Ecosystems at Risk project. Methodology was written up in generic form (and made available on the same website) in February 2004 in response to interest among CGAPS and the ISCs for development of a statewide network for early detection. Also, in February 2004, interest was expressed by HDOA (Nilton Matayoshi) in collaboration with USGS and others on invasive plant surveys (involving federal and state noxious weeds), assisted with CAPS funding from USDA.
- **USGS road surveys for selected weed species on the island of Hawaii**. USGS-BRD, Kilauea Field Station, has conducted surveys (2002-2005) of ca. 250 invasive species on foot along ca. 300 miles of roads and trails on Hawaii island in the vicinity of Hawaii Volcanoes National Park. (contact Jim_Jacobi@usgs.gov)
- **USFS monitoring of biocontrol agents**. USFS conducts monitoring of several agents released on gorse and UHM faculty have been monitoring fungal agents on Passiflora and Clidemia. USFS is planning a new release of a pest of strawberry guava. As part of that program they expect to be monitoring the impacts of the agent on both target and non-target species. However, at this point they are in planning stages only. (Julie Denslow, pers. comm., February 17 2004).

CNMI PROGRAMS

Fruit fly surveillance

As part of the SPC Fruit Fly Management program (see also Regional Programs, above), there are 60 fruit fly trapping sites in CNMI. Twenty seven are on Saipan, 25 on Rota, and 8 on Tinian. Each of the trap sites has one Cue-lure and one Methyl eugenol trap. In addition, host

fruit surveys are conducted cucumbers, which are regularly collected to assess damage by melon fly.

Monitoring for brown tree snake (BTS) at CNMI ports.
Monitoring for BTS is conducted at ports in Saipan, Tinian, and Rota by the CNMI government. Activities generally consist of snake trapping, nighttime surveys, and canine inspections of incoming Guam cargo.

Snake trapping has been conducted since 1993. In general the trapping program averages 300 traps, 150 on Saipan, 75 on Rota, and 75 on Tinian (Nate Hawley, pers. comm. April 25 2004). All traps are hung on the fence lines surrounding cargo staging areas and are maintained three times weekly. There are also 40 additional snake traps on each island that are utilized in responding to snake sightings. The CNMI BTS Trapping Program is often dependent on the availability of mice which are supplied from California (Hawley 2003). Random nighttime visual searches focus on locations of recent snake sightings or areas of high risk, and are conducted on the islands of Saipan, Tinian and Rota (Hawley 2003, Hawley et al 2003).

BTS specific detector dogs are used to inspect high-risk cargo from Guam. The CNMI BTS Program has five working detector dog teams, two under the Division of Agriculture (DOA)-Quarantine and three under Division of Fish and Wildlife (DFW)-BTS, that inspect cargo at the Saipan and Tinian ports of entry. The DOA-Quarantine teams are locally funded and commit only a portion of their time to detector dog work. The DFW teams include two recently certified detector dog teams on Saipan and one on Tinian, and are full-time BTS detector dog teams (Hawley 2003).

In 2003 the DFW-BTS program enlisted a professional advertising agency to develop and implement a nine-month advertising plan with the focus of increasing BTS awareness. As part of this program, DFW also secured various sponsorship entities that have donated gifts or services toward the outreach campaign. Verizon provided free cell phones/cell time to be designated as a BTS Hotline, sent out BTS information in their monthly billing statements, set up a BTS HOTLINE advertisement in the 2004 directory, provided funding to have two of the BTS Vehicles professionally painted with BTS Hotline 28-SNAKE information and graphics, and contributed phone cards and a cell phone for distribution as prizes during radio call-in BTS contests. The advertising plan was launched in May 2003 with a press conference attended by the Governor and Lt. Governor. Over 10,000 bumper stickers, 2000 posters, 15,000 temporary tattoos, 1000 t-shirts, and 400 hats were distributed throughout the CNMI by October 2003 (Hawley 2003).

In addition, the DFW-BTS program staff generally conducts approximately 60 presentations annually for school groups, civic groups, and cultural events. Instructional demonstrations for port of entry workers are given quarterly. Also, all Major Siting permits issued by CNMI's Coastal Resources Management Office and the Department of Environmental Quality require construction employees associated with the permit to receive a BTS Interdiction Workshop, which are given by DFW as required (Hawley 2003).

GUAM PROGRAMS

Fruit fly surveillance

As part of the SPC Fruit Fly Management program (see also Regional Programs, above), Guam has an unspecified number of fruit fly trapping sites that collectively contain 6 Cue-lure traps, 9 methyl eugenol traps and 5 Trimedlure traps, and conducts unspecified host fruit surveys. In addition, Guam carries out an awareness program that includes fruit fly posters set up at the airport, and a quarantine awareness program put out in schools, newspapers and on the radio.

AMERICAN SAMOA PROGRAMS

Port-of-entry inspections of foreign arrivals

American Samoa inspectors inspect incoming goods, but focus primarily on ensuring that duty has been paid on imports (Domingo Cravalho, pers. comm. April 25 2004). Many inspectors have limited knowledge of pests (Domingo Cravalho, pers. comm. April 25 2004). For example, although plant inspection (quarantine) services exist at the international airport, the Land Grant Program plant pathologist has never been called to do an identification during his entire five year tenure (Fred Brooks [Land Grant plant pathologist], pers. comm. March 11 2004).

Fruit fly surveillance.

As part of the SPC Fruit Fly Management program (see also Regional Programs, above), American Samoa maintains 8 fruit fly trapping sites on Tutuila island, each with one Cue-lure and one methyl eugenol trap. Host fruit surveys are also conducted and include regular collections of avocado, banana, breadfruit, guava, mango, papaya, and noni (*Morinda citrifolia*). In addition American Samoa carries out an awareness program that includes fruit fly posters at the airport and the wharf, and quarantine bins at the airport.

INVASIVE SPECIES PROGRAMS IN NEW ZEALAND PROGRAMS, AN EXAMPLE

As an island nation, New Zealand has developed invasive species programs to protect habitats and species that are threatened by invasions of, for example, snakes, cane toads, and disease-carrying mosquitoes. The Pacific Island Network can learn and utilize valuable information from these programs, due to ecological similarities (e.g. loss of endemic species, geographically isolated islands), but there are also many differences that prevent wholesale emulation of these programs.

For governing purposes, New Zealand is broken into 17 regions, and surveillance programs operate at both the national and regional level. National programs are administered through Ministry of Agriculture and Forestry (MAF), Department of Conservation (DOC), Ministry of Fisheries (Mfish), and Ministry of Health (MOH). The government's largest surveillance program is operated by MAF, the country's lead agency for pest detection. MAF's programs have historically focused mainly on the production sector, but they also provide surveillance services to DOC and MOH (Prime Consulting International Ltd [PCIL] 2002). For instance, DOC advises MAF about which conservation impacts and risks have not been considered with respect to import activities, and MAF may consequently set up a program to detect exotic species that impact indigenous taxa (Garthwaite pers. Com. 2003, PCIL 2002). DOC's primary focus is on surveillance for plant and animal pests already established in NZ, with an emphasis on conservation lands (PCIL 2002). MOH relies on MAF for much of their surveillance needs. Mfish has, or is developing, surveillance programs for both new to New Zealand and established

pests. Regional activities are laid out in Regional Pest Management Strategies and administered through Regional Councils. Regionally administered surveillance programs focus on monitoring established species (PCIL 2002).

Surveillance for organisms new to New Zealand

Surveillance by the Ministry of Agriculture and Forestry

The majority of detections of new species in New Zealand (NZ) are made through passive or 'general' surveillance, that is, by members of the public, reporting to the MAF 0800 number (Wilson et al 2004). MAF National Plant Pest Reference Laboratory (NPPRL) is the key government agency involved in the identification of suspect exotic pests from general surveillance activities. General surveillance relies on submissions (i.e., samples, or records of identifications) from sources such as the public, research organizations and museums, and usually only detects pests once they have established and dispersed in NZ. In addition to the public at large, horticultural and agricultural consultants, that specifically look for disease, are also considered part of the general surveillance system (Gill pers. comm. 2003). The NPPRL is required to respond to all 0800 telephone pest enquiries and to identify all organisms sent in by members of the general public who are encouraged to do so through the separately funded Public Awareness Program. In addition to general surveillance identifications, NPPRL maintains records of new organisms, hosts and distributions (Stephenson et al 2003).

Passive surveillance is strengthened via the Hazardous Substances and New Organisms Act which states that, "every person is under a duty to inform the Ministry, as soon as practicable in the circumstances, of the presence of what appears to be an organism not normally seen or otherwise detected in New Zealand." The act also specifies that "Governor-General may, by Order in Council, declare any organism to be a notifiable organism"; these organisms carry a legal obligation to report. MAF's primary nation-wide passive surveillance efforts occurr via the Protect New Zealand Campaign. The Campaign uses market research techniques to determine where and how to spend public awareness funds and determine success of previous outreach activities (Tollemache pers. comm. 2003). Some of Protect New Zealand's awareness efforts have included:(1) Creating collectable picture cards for children of the different detector dogs, with the pest prevention message on the back. (2) Distribution of pamphlets and other information materials targeting specific visitor or returning resident groups, such as resident Pacific Islanders, Chinese, or Japanese. (3) A targeted RIFA outreach campaign that included "See, Contain, Report" brochures, a pocket sized, water resistant card identifying high risk ant pests, designed for dock workers and cargo handlers. Initially part of the RIFA response and now the National Invasive Ant Program, this last project demonstrated the potential for programs based on awareness amongst target groups working in higher risk pathways (PCIL 2002).

- **Forest surveillance program.** MAF forest surveillance is focused on specific sites based on MAFs assessment of risks. These include urban forests, native forests, small forest blocks and commercial forests. Program locations, procedures, and frequency are summarized in the document entitled "Forest Biosecurity Surveillance – Summary of Programs" (not available on the internet); additional details were provided by Murphy pers. comm., 2003. There are five formal surveillance programs to detect organisms new to NZ which are funded and supervised by MAF, and which constitute the MAF forest surveillance program (PCIL 2002):

  a. general passive surveillance (undertaken by NPPRL and Forest Research).

b. risk site surveillance (carried out by Vigil Forest Health Advisory Services) is conducted at nominated sites where incursions may be detected as a result of the movement of people or cargo. There is some flexibility in risk areas to be searched. For instance, if high risk pests (such as certain species of wood borers) are found outside a risk site, that site will be added as a high risk site and surveyed for three years. In actuality, some areas in Auckland are searched seven times per year and others only once per year. As of September 2003, MAF was reassessing the risk site locations surveyed, and expected to have an updated strategy in place within six months.

c. Small block surveillance (carried out by Vigil Forest Health Advisory Services). Surveys of exotic trees within small commercial blocks of forest under 100 ha in size, in areas not covered by the Forest Owners Association's surveillance program. As of September 2003, MAF believed this program was ineffective and was reevaluating it.

d. Gypsy moth trapping (managed by AgriQuality; carried out since 1994/95). Trap effort is increased in areas when detections are made, e.g. traps increased from 17 in the Hamilton area to several hundred after one of the 17 traps captured a moth.

e. Wood boring and bark beetle trapping (managed by AgriQuality; begun in 2001). This program surveys mainly for beetles attracted to conifers, as no hardwood attractants are currently available (Murphy pers. comm. 2003). MAF is currently investigating new forest surveillance techniques, such as the use of sentinel forests planted in high risk areas.

- **Fruit Fly Surveillance**. Fruit fly surveillance has been in place since 1989 (PCIL 2002, Cowly 1990 in Stephenson et. al. 2003); the current program costs about NZ $1m/yr. Traps are operated in main centers, around ports, international airports, in areas with high levels of tourist activity and in areas of horticultural significance. Traps are baited with attractants that lure adult fruit flies into contact with an insecticide. Three lures are used in a grid at various spacings to trap economically important fruit flies (Cowly 1990 in Stephenson et. al. 2003). The traps are monitored every two weeks during spring, summer and fall months. There are a total of 2952 trap sites in the North Island (2107 in Auckland) and 506 sites in the South Island. Further intensified surveillance consisting of deploying additional traps at specified densities are carried out when fruit flies are detected (Stephenson et al 2003).

- **Surveillance of Livestock and domestic animals** (PCIL 2002, unless otherwise stated) is carried out by the National Center for Disease Investigation (NCDI). Suspect exotic diseases are reported by animal owners or veterinary practitioners to MAF through an 0800 number which is widely advertised and manned continuously. Appropriate follow-up is determined on the basis of the information received (Poland pers. comm. 2003). The following surveys are included:

  a. A 'passive' disease surveillance through veterinary diagnostic laboratories. This system is based on observation, examination and referrals sent through a chain of animal owners, veterinary practitioners, diagnostic laboratories and MAF's Animal Health Reference Laboratory.

  b. A Surveillance programme for BSE based on financial incentives for farmers and veterinarians to submit material from particular case types to diagnostic laboratories. These include $100 to veterinarians to test and check out, and an additional $60 to the

vetetrinarians if they send the head/brain to a government lab for testing (Poland pers. comm. 2003)

c. An active surveillance programme for arboviruses based on serological testing of cattle in sentinel herds; and for the vector Culicoides spp. using light traps

d. Periodic serological surveys for diseases considered to be exotic. Such surveys generally target disease organisms which have the potential to be present in the absence of clinical disease; use 17 sentinel cattle heards that are bled twice per year and tested for antibodies (Poland pers. comm. 2003)

e. An active surveillance programme for BSE, called the "MAF BSE Trade Risk Mitigation Programme", funded by the meat industry. Broiler poultry companies maintain intensive screening of grandparent and parent flocks for a limited range of potential epidemic, exotic poultry diseases. NCDI has carried out extensive survey and monitoring work over many years to verify NZs status with respect to the OIE list of fish diseases (i.e., data to support exports), e.g. an industry funded program to monitor the health of salmonids to support the export trade to Australia

- **Wildlife Disease Surveillance**. In 2003, a 2-year project was undertaken by MAF to develop a wildlife disease surveillance strategy. The project included development and application of criteria to prioritize diseases, sites and species for surveillance. It also included a finalized wildlife disease surveillance framework (Reed and Poland 2003).

- **National Invasive Ant Surveillance Program**. Initiated in 2001, as a result of the RIFA detection at Auckland International Airport (MAF 2001). Surveillance was extended beyond the Auckland RIFA incursion site, to include the rest of NZ, once it became known that RIFA established in Brisbane (MAF 2001). The program has been responsible for the detection and subsequent response to a number of species including yellow crazy ant (*Anoplolepis gracilipes*), ghost ant (*Tapinoma melanocephalum*), tropical fire ant (*Solenopsis geminata*) and RIFA (*Solenopsis invicta*) (MAF 2004a). Prioritization of areas for wider surveillance was done via an assessment of risks of entry, dissemination, and establishment of RIFA in NZ. High-risk sites identified (MAF 2001) include four international airports (2 military), 12 international seaports, and an unspecified number of garden centers, marinas and container unpacking sites. Specific sites are selected each year for surveillance activity based on previous incursion and detection history, climate, and trade pattern (O'Connor 2005).

  General procedure: selected sites are overlaid with a 15m x 15m grid, and grid cells containing suitable ant habitats are visually inspected and baited with attractants. Baits are laid out for two- hour periods to coincide with optimum foraging conditions. All ants detected are identified (O'Connor 2005). Bait include both a carbohydrate and a fatty protein. Originally, when looking for RIFA at Auckland airport, a mix of smooth peanut butter, soybean oil and fatty sausage was used (MAF 2001); when the program was expanded, a carbohydrate/sugar bait was also used (Pascoe pers. comm. 2003). Suitable ant habitat includes warm sunny locations close to water sources such as open drains and creeks, taps, leaky water mains, grassy areas, the base of trees, under debris, logs, or rocks (Pascoe, pers. com. 2002; MAF 2004b). Surveillance activities are conducted only if air temperatures are consistently above 15ºC; baits are placed only if it is unlikely to rain between placement and reading (MAF 2001).

In addition to surveillance at high-risk sites, RIFA awareness campaigns are targeting personnel most likely to encounter any new nests such as employees at public health services, garden centers, veterinarians, DOC regional offices, Royal Forest and Bird protection society, SPCA, MAF quarantine service and pest control operators. Further outreach campaigns are targeting the general public. For instance, pamphlets were distributed to households, box-holders, businesses and rural addresses within an area identified by the CALPUFF windspread model to have an 80% probability of having a flying queen landing should mating flights have occurred at Auckland airport

- **Apiary surveillance**. Passive surveillance for honeybee diseases is conducted via beekeepers, backed by diagnostic labs (PCIL 2002). Active surveillance for honeybee diseases is conducted through a national program partly funded by MAF and carried out primarily by trained apiarists. Detection of other diseases during inspections of commercial apiaries for American foulbrood is incorporated into the program. MAF surveillance standard for diseases of honeybees are available online.

- **Crop surveys** (no longer conducted). The MAF has been conducting crop surveys for a number of years. Initial surveys concentrated on examining specific crops for all pests and diseases present (Ganev and Braithwaite 2003). Crop surveys were conducted from 1989-1999 by MAF NPPRL, and consisted of surveys on one major crop or crop group per year to establish the current status of pests (as defined by the International Plant Pest Protection Convention in 2002). Surveys were designed to provide 95% probability of detecting pests occurring at > 1% of sites, which required a sampling regime of 50-250 plants sampled from more than 300 sites. After 10 years it was concluded that adequate baseline data had been obtained and the surveys were discontinued. It was also recognized that these surveys would not be adequate to detect pests in time for successful eradication (Stephenson et al 2003). It is now left to the farmers, growers and their advisers to report incursions of exotic organisms (PCIL 2002).

- **Industry Surveillance**. Industries often set up their own surveillance system with input from MAF, then carry out the surveillance activities independently (Gill pers. comm. 2003). For example, Zespri (a company marketing Kiwifruit) undertakes an independent annual Surveillance programme for organisms found and diagnosed on kiwifruit, which maintains the kiwifruit pest list and assists in determining markets for which the fruit is eligible (PCIL 2002).

Surveillance by the Department of Conservation

- **Insects and disease in DOC forests**. Surveillance for early detection of introduced insects or diseases in forest areas owned by DOC was conducted for a number of years. This work consisted of aerial surveillance with ground checks, and ground surveys via forest road systems. The program was reviewed in 2001 and as a result, DOC forest surveillance was changed to include the First Campsite Monitoring (Ross 2002).

- **First campsite monitoring**. Surveillance of indigenous forest sites consists of surveying preselected “first night” campsites (maximum of 68 in total) which experience high tourist traffic (Ross 2002). Program location, process, and frequency are summarized in the hardcopy document “Forest Biosecurity Surveillance – Summary of Programs”

- **Marine Reserve monitoring**. Fourteen marine reserves have monitoring programs in place. Monitoring is focused on habitat features and communities, or selected key species, in order to identify changes in diversity, abundance, and biomass or impacts of human activity. However, these monitoring activities also serve to identify organisms not previously present, or that have attained unusually high numbers (PCIL 2002).

Surveillance by the Ministry of Fisheries

The Ministry of Fisheries (Mfish) established a passive surveillance network in which volunteer coastal area residents monitor the environment for new pests. Public outreach further includes distribution of pamphlets and posters to clubs, shops, councils, associations, researchers, and agencies associated with the coast. These materials provide information on Undaria and the `top ten' unwanted species. A Marine Invaders Hotline for reporting suspect organisms has been set up.

In addition, Mfish is in the early stages of developing an active surveillance program to detect organism new to New Zealand's marine environment. The program focuses on high-risk coastal areas, including ports and marinas. Baseline surveys were initiated to determine which native and introduced species were already present in high-risk ports and marinas. The surveys are designed to provide background information for later sentinel surveillance. The surveys are conducted in areas of the ports considered at high risk of receiving non-indigenous species because of the high volume of ship traffic. The port surveys included: quadrat sampling and video transects of fouling organisms on wharf pilings and other hard surfaces, visual searches by scuba divers of marine and itertidal habitats, benthic grab samples for soft-sediment fauna, epibenthic sled tows to capture large surface-dwelling organisms, trapping using four different types of traps designed to capture starfish, crabs, fish, and small crustaceans, and small-core sampling to detect dinoflagellate cysts. Baseline surveys of all 13 major trading ports and 3 northern marinas, the principal entry points for international yachts and other recreational boats, were expected to be completed by 2004 and would form the basis of future monitoring of port environments in NZ (Inglis 2002). Eight ports will be resurveyed after three years, to estimate infestation rates that can assist in determining surveillance needs (Hewitt pers. comm. 2003).

- **Target species surveys**. A program for surveillance for seven targeted species of unwanted organisms in eight high risk harbors started in late 2002. The project includes the development of techniques for on-going surveillance. This work is carried out in collaboration with researchers in Australia where some of the unwanted organisms are already present. The program identified seven high risk marine species via risk profiling. These included: European fanworm (*Sabella spallanzanii*), European shore crab (*Carcinus maenas*), Northern Pacific seastar (*Asterias amurensis*), Chinese mitten crab (*Eriocheir sinensis*), green alga (*Caulerpa taxifolia*), Chinese clam (*Potamocorbula amurensis*), Japanese seaweed (*Undaria pinnatifida*). Eight high risk points of entry were identified (Whangarei, Waitemata, Tauranga, Wellington, Nelson, Lyttelton, Otago, and Bluff), through risk profiling of shipping movements. Hydrodynamic models and predictive habitat modeling were used concurrently to direct field sampling to areas where the chances of early detection are greatest. Researchers will use these data to determine detection thresholds for the seven species (Inglis et al. 2003; Campbell and Hewitt 2005; Hewitt pers. comm. 2003).

- **Ballast Water Surveillance**. Compliance Monitoring of Ballast Water Exchange (PCIL (2002): All vessels >500 DWT must provide details of the origin and volumes of the ballast water they are carrying, and their intentions with respect to discharge of the ballast in NZ waters, via completion of a Vessel Ballast Report Form (VBRF). Data from the VBRF are collated and filed electronically. Mfish hopes to eventually use these data to target their surveillance on high-risk vessels. It is mandatory that VBRF are filled out, but ballast water is not tested. As of 2002, there was no reliable method to verify compliance of the vessels with New Zealand's ballast water requirements. As a result, the accuracy and reliability of data on VBRFs was questioned by PCIL (2002).

  A 2-year study initiated in 1995 was designed to develop a standardized method to sample ballast water, investigate invasive species risks, and identify high risk vessels. The results were published in a technical report and provided data for the ballast water sampling manual. Based on these reports a program to improve monitoring of vessel compliance with New Zealand ballast water exchange requirements is being initiated. Researchers are developing a portable indicator test that customs officers can use to check whether ships and boats have brought in ballast water from another port.

Surveillance by the Ministry of Health

- **Mosquito surveillance**. Mosquito surveillance began in 1993-94. A 10yr plan of spot checks and surveys was terminated in 1997-98 as it was no longer considered the most appropriate method for detection. The program was subsequently updated and standardized throughout NZ. The program now actively targets regions according to their assessed risk for the introduction and establishment of exotic mosquitoes, with the greatest resources committed to areas and times of highest risk. The minimum surveillance effort, at low risk seaports, includes inspection of all first-port-of-call vessels, fumigation of all containers with tires, and dockside surveillance using pre-positioned tires as monitoring devices during months with average temperatures above 10ºC. High risk area surveillance includes activities throughout the year and involves surveillance at seaports, airports and other areas (Hearnden et al. 1999). For instance, there are two programs in Auckland: 1) weekly and biweekly monitoring and surveillance at the four international ports, and 2) regular surveys of areas identified as favorable habitats for *Ochlerotatus camptorhynchus*. The surveys involve a combination of larval dipping and setting of light traps for adults (Aukland District Health Board 2004). In other areas, larval traps are also used (Public Health South Web 1). A Public Health Report summarizes NZ's previous and current mosquito surveillance methods.

Surveillance by other agencies and organizations

- **Surveillance and monitoring of plant and animal pests in freshwater ecosystems** is under development by the National Institute of Water and Atmospheric Research (NIWA). It is anticipated that this surveillance program will be operative by 2007 (Hall 2004). Current surveillance resources include: (1) the NIWA NZ Fresh Water Fish Database – an historic archive of information on native and introduced fish species and their habitats dating back to the 1960's and containing more than 18,000 records (PCIL 2002); (2) NIWA Freshwater Biodata Information System (FBIS) this database contains fish, algae, aquatic plant and invertebrate data and metadata gathered from New Zealand's

freshwater streams, rivers and lakes; (3) Protocols for sampling macroinvertebrates in wadeable streams.

- **FOA forest surveillance**. This program is funded and organized by the Forest Owners Association (FOA) and provides surveillance coverage of up to 1.25 million hectares of commercial plantation forests (Ross 2002). Surveillance is conducted to 1) detect forest pests and diseases new to a particular forest and report on existing pests, and 2) to report on overall forest health condition. Surveillance is conducted in accordance with procedures established by the FAO and are based on the Carter Model (Carter 1989; Ross 2002). The Carter model prescribes guidelines for varying intensities of surveillance ranging from the aerial survey, to drive through roadside surveys, to random point sampling (PCIL 2002). This commercial surveillance program does not extend to adjacent native forests, which could be an unknown reservoir of both exotic and endemic pests (PCIL 2002). It is supported via a levy per hectare of forest owned (Murphy pers. comm. 2003). Program procedures and locations are summarized in "Forest Biosecurity Surveillance – Summary of Programs".
- **Marine Bioinversion Research**. Cawthron Marine Biosecurity research, a private non-profit research center, is running an ongoing surveillance programme for exotic marine organisms in hulls and sea chests of commercial vessels dry-docked for maintenance (PCIL 2002). Findings and sampling methods were published in a report by Dodgshun and Coutts (2002).

Surveillance for organisms already established in New Zealand

Surveillance by the Ministry of Agriculture and Forestry

- Detection (and control) of water hyacinth, salvinia, Johnson spruce, and Cape tulip. Although the major focus of MAF Plant Biosecurity with respect to surveillance is for organisms new to New Zealand, they have a limited number of surveillance programs to monitor established pests and diseases. These currently include Johnson grass, Water hyacinth, Salvinia and Cape Tulip (PCIL 2002), for which eradication programs are in place (Gill pers. comm. 2003). MAF relies on members of the public and Regional pest management staff for surveillance (Gill pers. comm. 2003).

Surveillance by the Department of Conservation

In general, DOC relies heavily on the public and public education for surveillance (Broome pers. comm. 2003). DOC produces pamphlets, brochures and other materials that are distributed in a variety of venues, for instance, to conservancy visitors (see 2.3), and on the docks at lakes (freshwater pest information). Examples include the Watch for these Weeds series, and the Help Protect New Zealand's Offshore Islands brochure.

Site-specific plans for managing lands in DOC charge include surveillance activities relevant to the local risks and conditions of each island district. As of 2003, these plans were not nationally consistent, and DOC was in the process of moving toward developing consistent Quarantine and Contingency plans for each district, based on a template (Broome pers. comm. 2003; see "Southland Quarantine and Contingency plan," not available on the internet). These plans incorporate quarantine, surveillance and response, with much more emphasis placed on quarantine than surveillance. These and other DOC plans now incorporate the use of risk assessment, predictive modeling to determine possible extent of infestation, and cost-benefit

analysis to determine whether and what type of action a detection warrants. (Broome pers. comm. 2003). Surveillance programs are directed at monitoring pests in order to mount an appropriate response when threats are recognized (PCIL 2002).

As an example of a site-specific strategy, the following are components of the Quarantine and Contingency Plan for the Islands in the Southland Conservancy, which serve surveillance functions:

(1) Permanent bait station and trap sets (for predators and inverts): The plan identifies 31 locations, among three different island/island groups, where trap and bait station activities must be conducted (to serve both quarantine and surveillance functions). For each island/island groups, the plan specifies location of traps/bait stations, e.g. South East Air hanger, Halfmoon Bay Wharf, trap type, bait station type, target pest, number of traps/stations, traps/station spacing, trap/station servicing interval, and bait type. The plan also stipulates that all pest captures and bait take is to be reported in writing to the Program Manager.

(2) Pests found during transit or after arrival: The plan stipulates that voucher specimens, with full details, should be collected and sent to an expert for identification if necessary.

(3) Rodent surveillance: For all islands except those with permanent station/trap sets already established, the plan stipulates that islands visited for more than five consecutive nights be checked for rodent presence, and all islands visited for less than five consecutive nights be checked at least once every five years if visited. The plan also stipulates acceptable techniques to be used (trapping, tracking tunnels, gnaw sticks, or sign checks if non target issues are a risk) and surveillance effort (minimum rate of 15 trap or tunnel nights run for three nights per 100 ha of island).

(4) Surveillance only sites: The plan stipulates the island, target pest, technique, site and frequency of surveillance for pests at locations at which they are not covered via permanent bait station/trapping. The only surveillance only site in the Southland Conservancy plan is Stewart Island, stoat surveillance via dog search, once per year.

(5) Weed surveillance: According to the quarantine and contingency plan, all weed surveillance work is to follow the standards in the appropriate area weed surveillance plan.

(6) Invert and disease surveillance: All invert or disease surveillance is to follow the standards in any appropriate surveillance plans that exist.

(7) Surveillance training and reporting: According to the plan, DOC staff who work on islands are to be trained to a level of proficiency in the detection and recognition of pests and pest sign. The plan also stipulates that training should include fieldwork with experienced staff, use of current references to pest identification, and access to expert advice. Reporting procedures of surveillance monitoring is specified: all results reported to the Area Manager via the Pest Invasion Form included in the plans appendices or operational reports relevant to surveillance.

(8) Public awareness: Information about pest invasion risks to islands for visitors is also stipulated in the plan. The plan specifies what info and which pamphlets are to be given to which island visitors, e.g. “The Pest, and Disease Quarantine pamphlet and a Quarantine Checklist are to be issued to each trip leader. A Self-Audit Check Sheet, a

Minimum Impact Code pamphlet and the Protect New Zealand's Offshore Islands pamphlet are to be given to each expedition member." It also states what signage regarding pest quarantine and prevention is to be posted where. Many of these materials include instructions to report any sightings of pests to DOC.

- **Weed surveillance program**. Weed detection/control is DOC's most nationally standardized program (Dawson pers. comm. 2003). It includes a WRA (based on Australia's), a weed database, and a ranking system for determining if the weed is to be locally controlled, eradicated, or left alone (Dawson pers. comm. 2003). Since 2001 DOC's national Weed Surveillance program has been operating under an SOP, which provides for Conservancy Weed Strategies, weed program manager designation in each office, development of area invasive weeds work plans, and focus on sites with a high risk of incursion and/or conservation value (PCIL 2002).

- **National vertebrate pest surveillance SOP**. DOC is working toward developing a national SOP for vertebrates, including predators and fish. (Broome pers. comm. 2003). Currently, predator surveillance includes surveillance for mustelids and rodents on various islands.

- **Wildlife Disease**, as per PCIL (2002) Some autopsies of birds and marine mammals are conducted and results entered into the Massey University Huia pathology database; DOC plans to expand this work to include samples from sick animals and baseline pathogen surveillance. Threatened species that die in captivity or are found freshly dead in the wild are necropsied where possible, and results entered into the Massey University Huia database. Health investigations of specific captive and wild species (kiwi, black stilts, North Island Kokako, Tuatara, Takahe, NZ Shore Plover, North Island Kaka, NZ Falcon, Campbell Island Teal, Brown Teal, hihi) are conducted prior to their reintroduction into the wild. Translocated species are disease screened pre-translocation. Passive Surveillance is conducted in association with other survey and research work.

- ***Undaria* (Japanese kelp) surveillance**. As of 2001, DOC carried out surveillance for the Japanese kelp *Undaria pinatifida*, as part of a project aimed at eradicating the species from Stewart Island and protect high value areas (PCIL 2002). In addition to eradication efforts, DOC monitored vessels in southern NZ to reduce the chance of new introductions of this species to Stewart Island, and the spread to Fiordland and the Sub-Antarctic. Vessels were inspected for *Undaria*, and owners/operators informed of its potential impacts and steps they should take before moving to uninfested areas. Funding for managing *Undaria* in Southland was slated to cease in June 2002, but Mfish planned to continue the vessel monitoring component as part of an Mfish Vector Management Program (Mfish 2001).

Surveillance by the Ministry of Fisheries

- **Vector Management Program.** MFish has initiated a vector management program to reduce the spread of the seaweed *Undaria pinnatifida* to the Chatham and sub-Antarctic Islands. The program is focused primarily on vessel and marine farming vectors. Surveillance includes dive surveys of vectors such as boat hulls, in a number of locations around New Zealand. Mfish uses an incentive program (a prize of a GPS system is offered) to boat owners to complete survey forms (PCIL 2002).

Surveillance by the Ministry of Health

- **Toxic algae monitoring**. Distribution of toxic dinofalellates/algae is monitored by MOH in order to avoid toxic marine food entering the food supply (PCIL 2002). The program includes regular shellfish flesh testing via assessment of toxicity through mouse bioassays, and phytoplankton monitoring (Holland et al. 2001). A new program is being developed to provide chemical analytical data for individual toxins in place of bioassay screen test results (Holland et al 2001).

Surveillance by Regional Councils

Pest plant surveillance via National Plant Pest Accord (NPPA) came into effect in October 2001. The focus of the accord is to prevent the sale, distribution, and propagation of specified pest plants within New Zealand (NPPA 2001). The Accord is a cooperative agreement between regional councils and government departments with biosecurity responsibilities. Under the Accord, all signatory regional councils will undertake surveillance to prevent the commercial sale, propagation or distribution of an agreed list of pest plants (NPPA 2001). The NPPA list is dynamic, with additions made periodically via consultation with a technical advisory group. The list includes species with limited distribution and also problematic species that are not yet known to occur in New Zealand. Councils can add species of local concern to the list in their RPMS. Councils undertake routine surveillance and inspection of plant nurseries and other commercial outlets where listed plants may be found (e.g., pet stores selling aquatic plants). Individual councils decide upon the nature and frequency of inspections, but consideration must be given to ensuring that programs are conducted in a manner that gives effect to the accord. (NPPA 2001; Auckland Regional Council 2002; also see Protect New Zealand 2002).

Regional councils manage established pests, via development and implementation of Regional Pest Management Strategies (RPMS). RPMS stipulate specific surveillance and monitoring associated with local pest management objectives. For instance, the Auckland RPMS (Auckland Regional Council 2002) stipulates that the Regional Council shall monitor the extent to which the objectives set out in Part II of the Strategy are being achieved by:

> a) Annually surveying, mapping and recording site status for all Total Control pests, and producing graphs and tables to show changes in site status and pest distribution;
>
> b) Recording the number of public complaints pertaining to individual pest plants and animal and instances of non-compliance with Strategy rules;
>
> c) Recording the number of public enquiries in relation to individual pest plants and animals, in regard to requests for information;
>
> d) Annually monitoring all Possum and Goat control operations to determine performance results;
>
> e) Undertaking periodic monitoring of native forest areas to ascertain forest condition; and,
>
> f) Annually surveying a proportion of the region (60 000 ha to 100 000 ha) to locate infestations of low incidence pests and check key incursion points; and
>
> g) Recording the number of groups/individuals who participate in Community Initiatives Programmes and the total area of land under community control, and monitor the effectiveness of the control work carried out.

As per the National Plant Pest Accord, the Auckland RPMS also identifies a list of regional "Surveillance Pest Plants" that, with respect to surveillance, are to be treated in the same way as those on the NPPA list. The monitoring programs in RPMS are inconsistent across regions, and often in conflict when viewed from a national perspective (PCIL 2002).

SUMMARY

The oceanic islands of the Pacific Island Network (PACN) are extremely vulnerable to biological invasions. Because endemic species on these islands evolved in relative isolation, they are susceptible to the damage caused by invasive species that readily adapt to new environments. This report summarizes the challenges, public perceptions, policies, and legislation relevant to the protection of natural resources within the PACN region.

The National Park Service is tasked with monitoring ecological change and impairment caused by invasive species. Detection of potential new invasions will require that the PACN parks work closely with partners and the public to rapidly and effectively respond to impending invasions, as well as to control or eradicate existing invasions. The PACN should develop flexible approaches and protocols for early detection of invasive species, with a view toward maximizing use of limited funds to catalyze necessary improvements. The PACN may be uniquely positioned to lead the way nationally in developing and conducting effective invasive species programs.

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ABBREVIATIONS AND ACRONYMS

ALKA	Ala Kahakai National Historic Trail
AMME	American Memorial Park
APHIS	Animal and Plant Health Inspection Service
BN-Certifed	Burrowing Nematode certified
BSE	Bovine Spongiform Encephalopathy
BT CELISA	Bluetongue Competitive Enzyme-Linked Immunosorbent Assay
BTS	Brown Tree Snake
CALPUFF	
CDC	Centers for Disease Control
CFR	Code of Federal Regulations
CGAPS	Coordinating Group on Alien Pest Species
CRAMP	Coral Reef Assessment and Monitoring Program
DFW-BTS	Division of Fish & Wildlife- Brown Tree Snake (CNMI)
DHS	Department of Homeland Security (U.S.)
DOA	Department of Agriculture (U.S.)
DOC	Department of Conservation (U.S.)
DOD	Department of Defense (U.S.)
DOH	Department of Health
DWT	Deadweight Ton
EIS	Enviromental Impact Statement
EPMT	Exotic Plant Management Teams
FAO	Food and Agriculture Organization of the United Nations
GIS	Geographic Information System
H.R.	House Rule
HALE	Haleakala National Park
HAR	Hawaii Administrative Rules
HAR	Hawaii Administrative Rules
HAVO	Hawaii Volcanoes National Park
HBS	Hawaii Biological Survey
HDLNR-DOFAW	Hawaii Department of Land and Natural Resources- Division of Forestry and Wildlife
HDOA	Hawaii Department of Agriculture
HDOH VCG	Hawaii Department of Health Vector Control Group
HOGA	Hawaii Orchid Growers Association
IgM ELISA	……..Enzyme-Linked Immunosorbent Assay
ISC	Invasive Species Committee
ISSG	Invasive Species Specialist Group
KAHO	Kaloko-Honokohau National Historical Park (Hawaii Island)
KALA	Kalaupapa National Historical Park (Molokai)
LFA	Little Fire Ant
MAF	Ministry of Agriculture and Forestry (New Zealand)
Mfish	Ministry of Fisheries (New Zealand)
MOH	Ministry of Health (New Zealand)
NCDI	National Center for Disease Investigation (New Zealand)
NEPA	National Environmental Policy Act (U.S.)
NIS	Non-indigenous Invasive Species
NIWA	National Institute of Water and Atmospheric Research (New Zealand)
NPPA	National Plant Pest Accord (New Zealand)
NPPRL	National Plant Pest Reference Laboratory (New Zealand)
NPS	National Park Service (U.S.)
NPSA	National Park of American Samoa
NRC	Natural Resources Challenge
OIE	Office International des Epizooties (World Organization for Animal Health)

OTA	Congressional Office of Technological Assessment (U.S.)
PACN	Pacific Island Monitoring Network (U.S. NPS program)
PCIL	Prime Consulting International Ltd.
PCR	Polymerase Chain Reaction
PICT	Pacific Island Countries/Territories
PRNT	Plaque Reduction Neutralization Test
PUHE	Puukohola Heiau National Historic Site (Hawaii Island)
PUHO	Puuhonua o Honaunau National Historical Park (Hawaii Island)
RIFA	Red Imported Fire Ant
RPMS	Regional Pest Management Strategies
RT PCR	Reverse Transcriptase Polymerase Chain Reaction
SLE	St. Louis Encephalitis virus
SOP	Standard Operating Procedure
SPC	Secretariat of the Pacific Community
SPCA	Society for the Prevention of Cruelty to Animals
SPS Agreement	Agreement on the Application of Sanitary and Phytosanitary Measures
TNC	The Nature Conservancy
UH-CTAHR	University of Hawaii College of Tropical Agriculture and Human Resources
UHM	University of Hawaii at Manoa
USAR	USS Arizona Memorial (Oahu)
USDA	United States Department of Agriculture
USDA-APHIS-AQIM	Agricultural Quarantine Inspection Monitoring
USDA-APHIS-PPQ	Plant Protection and Quarantine (USDA subsidiary)
USEPA	United States Environmental Protection Agency
USFS	United States Forest Service
USGS	United States Geological Survey
VBRF	Vessel Ballast Report Form
WAPA	War in the Pacific National Historical Park (Guam)
WHAP	West Hawaii Aquarium Project
WNV	West Nile Virus